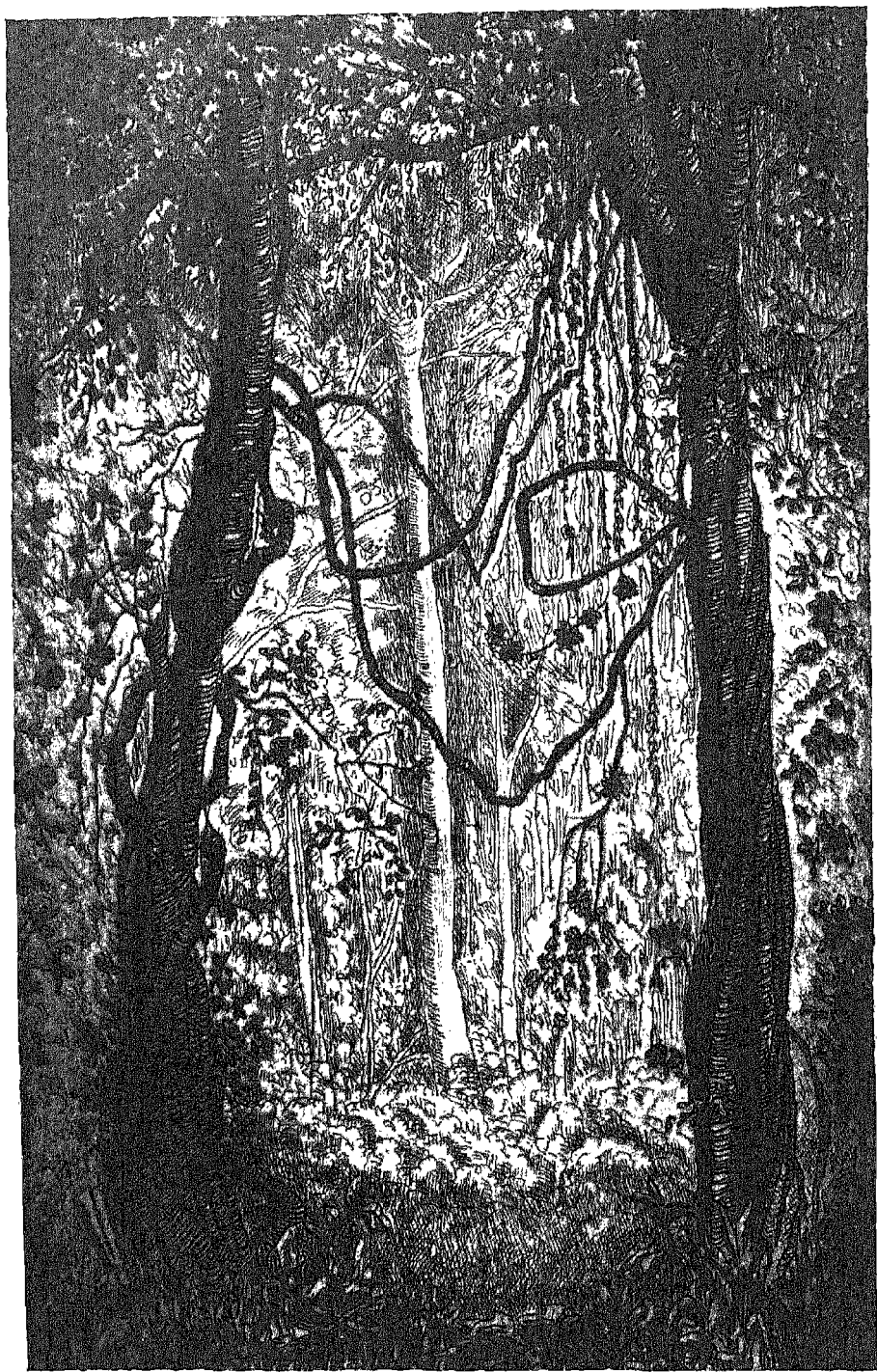


INDIAN AGRICULTURAL
RESEARCH INSTITUTE, NEW DELHI.

I. A. R. I. 6.

MGIPC-81-6 AR/51-7-754-10,000.

MANUAL
OF
INDIAN
FOREST BOTANY



From an etching by Eleanor Bor
Evergreen Hill Forest, Kohima, Naga Hills

MANUAL OF INDIAN FOREST BOTANY

N. L. BOR

C.I.E., M.A., D.Sc., Sc.D., F.R.S.E. etc.

Assistant Director, Royal Botanic Gardens, Kew ;
formerly Forest Botanist of the Forest Research
Institute, Dehra Dun



GEOFFREY CUMBERLEGE
OXFORD UNIVERSITY PRESS

47191



IARI

Indian Ag.

Oxford University Press, Amen House, London E.C.4
GLASGOW NEW YORK TORONTO MELBOURNE WELLINGTON
BOMBAY CALCUTTA MADRAS KARACHI CAPE TOWN IBADAN
Geoffrey Cumberlege, Publisher to the University

First published 1953

A C K N O W L E D G E M E N T

Our thanks are due to Dr J. Hutchinson, F.R.S., and
Messrs Macmillan & Co. Ltd, for giving us permission
to publish an adapted version of the KEY TO THE
FAMILIES OF DICOTYLEDONS which appears as
an Appendix to this book.

*Text printed in India by S. N. Guha Ray at Sree Saraswaty Press Ltd, 32 Upper
Circular Road, Calcutta; illustrations printed by The Times of India Press,
Bombay and published by Geoffrey Cumberlege, Oxford University Press, Bombay*

FOREWORD

IN his monumental book on *Indian Trees*, Sir Dietrich Brandis expressed the hope that the local Forest Floras of the future would be based mainly on the study of the trees and shrubs as they grow in the forest, and written in India. Dr Bor's book is not just a local Forest Flora, but deals with the whole country covered by Hooker's *Flora of British India*, and now divided politically into India, Pakistan and Burma. No one is perhaps more qualified for the work than Dr Bor, who, together with his wife,¹ spent twenty-five years in the Indian Forest Service, and since his retirement has continued his studies of the flora of this vast region in the Herbarium of the Royal Botanic Gardens, Kew. His book, therefore, should be invaluable to the field botanist for whom it has been specially written.

It is a very old saying that a prophet is rarely recognized in his own country, not during his lifetime at any rate. But Dr Bor is evidently not hidebound by tradition and has boldly adopted the latest system proposed by the writer of this note, as used in the *Flora of West Tropical Africa* (1927-36), his *Botanist in Southern Africa* (1946), and in his *British Flowering Plants* (1948). His chapter on the Progress of Classification (p. 27) gives a concise history of the subject and his reasons for adopting this phylogenetic system.

Systematic botanists are as a rule very conservative, and convenience has constantly been a bar to the adoption of new systems of botany. The artificial system of Linnaeus served its purpose for nearly three-quarters of a century, and was replaced very slowly by the system of the Jussieus in France, subsequently further elaborated and improved by De Candolle in the great *Prodromus*, and finally by Bentham and Hooker in their classical *Genera Plantarum*. The last mentioned was planned before the advent of the Darwinian theory of evolution published in 1859, but was not later influenced by it to any extent. The German system of Engler and Prantl, however, had the full benefit of the new theory, and the families were largely rearranged on more phylogenetic lines. That this system has not been universally adopted is now botanical history.

Few now regard the *Amentiferae*, which are placed first in the Engler and Prantl system, as being in any way primitive, and

¹ See *Adventures of a Botanist's Wife*, by E. C. Bor (Hurst and Blackett, 1952).

many now consider the *Magnoliaceae* and *Ranunculaceae* to represent the most ancient types of living flowering plants.

The problem, then, is to bridge the gap between these families and the higher *Gamopetalae*, such as *Verbenaceae* and *Labiatae*, and to assign the correct place for Monocotyledons.

For this purpose the system adopted recognizes two basic divisions, a predominantly *woody* group, LIGNOSAE, beginning with the *Magnoliaceae* on p. 41, and a predominantly *herbaceous* phylum, HERBACEAE, starting with the *Ranunculaceae* on p. 311, whilst the Monocotyledons are placed at the end, finishing up with the highly advanced family *Gramineae*.

I sincerely hope that the practical use of the system in this unique book will help the student to a better understanding of the forest flora of the vast region dealt with, and that it will aid him to understand and solve the many complex problems connected therewith.

J. HUTCHINSON

Kew, 1953

CONTENTS

PREFACE	...	...	...	xiv
THE VEGETABLE KINGDOM	...	...	...	I
Cryptogams	...	...	...	2
Phanerogams	...	...	...	5
Phylum I : Gymnospermae	...	...	...	5
I. Bennettitales	...	...	...	6
II. Cycadofilicales	...	...	...	6
III. Cycadales	...	...	...	7
IV. Ginkgoales	...	...	...	8
V. Cordaitales	...	...	...	8
VI. Coniferales	...	...	...	9
VII. Gnetales	...	...	...	24
Phylum II : Angiospermae	...	...	...	27
The Progress of Classification	...	...	...	27
Subphylum I : Dicotyledones	...	...	...	41
I. Lignosae	...	...	...	41
1. Magnoliales	...	...	...	41
2. Annonales	...	...	...	44
3. Ebenales	...	...	...	45
4. Laurales	...	...	...	47
5. Dilleniales	...	...	...	60
6. Coriariales	...	...	...	61
7. Rosales	...	...	...	62
8. Leguminosae	...	...	...	68
9. Cunoniales	...	...	...	95
10. Araliales	...	...	...	98
11. Styracales	...	...	...	103
12. Hamamelidales	...	...	...	105
13. Salicales	...	...	...	108
14. Myricales	...	...	...	112
15. Fagales	...	...	...	113
16. Juglandales	...	...	...	125
17. Casuarinales	...	...	...	127
18. Urticales	...	...	...	128
19. Bixales	...	...	...	142
20. Thymelaeales	...	...	...	146
21. Proteales	...	...	...	148

22. Pittosporales	...	...	...	149
23. Capparidales	...	...	...	150
24. Tamaricales	...	...	...	152
25. Violales	...	...	...	153
26. Polygalales	...	...	...	153
27. Passiflorales	...	...	...	154
28. Cucurbitales	...	...	...	155
29. Cactales	...	...	...	156
30. Tiliales	...	...	...	157
31. Malvales	...	...	...	164
32. Malpighiales	...	...	...	165
33. Euphorbiales	...	...	...	167
34. Theales	...	...	...	187
35. Ericales	...	...	...	196
36. Guttiferales	...	...	...	199
37. Myrtales	...	...	...	203
38. Celastrales	...	...	...	224
39. Myrsinales	...	...	...	229
40. Olacales	...	...	...	235
41. Santalales	...	...	...	237
42. Rhamnales	...	...	...	240
43. Rutales	...	...	...	245
44. Meliales	...	...	...	251
45. Sapindales	...	...	...	258
46. Loganiales	...	...	...	268
47. Apocynales	...	...	...	279
48. Rubiales	...	...	...	288
49. Bignoniales	...	...	...	293
50. Verbenales	...	...	...	299
II. Herbaceae	...	...	...	311
51. Ranales	...	...	...	311
52. Berberidales	...	...	...	312
53. Aristolochiales	...	...	...	314
54. Resedales	...	...	...	317
55. Polygonales	...	...	...	318
56. Chenopodiales	...	...	...	318
57. Lythrales	...	...	...	320
58. Primulales	...	...	...	323
59. Sarraceniales	...	...	...	324
60. Umbellales	...	...	...	325
61. Campanales	...	...	...	326
62. Asterales	...	...	...	326
63. Solanales	...	...	...	328
64. Personales	...	...	...	329
65. Geraniales	...	...	...	332
66. Boraginales	...	...	...	333
67. Lamiales	...	...	...	333

CONTENTS

ix

Subphylum II : Monocotyledones	...	...	335
Classifications of the Monocotyledons	...	...	335
68. Zingiberales	...	...	335
69. Liliales	...	...	337
70. Agavales	...	...	339
71. Palmales	...	...	340
72. Pandanales	...	...	351
73. Graminales	...	...	352
GETTING TO KNOW THE TREES	...	...	359
APPENDIX—KEY TO THE FAMILIES OF DICOTYLEDONS	...	...	377
INDEX	...	...	425

ILLUSTRATIONS

Evergreen Hill Forest, Kohima

Frontispiece

PLATES I-XXXI (at end)

- | | |
|-----------------------------|--|
| I. ANONACEAE | 1. <i>Orophaea thomsonii</i> Bedd.
2. <i>Polyalthia coffeoides</i> Benth. et Hook. f. |
| II. EBENACEAE | 1. <i>Maba buxifolia</i> Pers.
2. <i>Diospyros embryopteris</i> Pers. |
| III. DILLENACEAE | 1. <i>Dillenia indica</i> Linn.
2. <i>Dillenia pentagyna</i> Roxb. |
| IV. HYDRANGEACEAE | 1. <i>Dichroa febrifuga</i> Lour.
2. <i>Hydrangea robusta</i> Hook. f. et Thoms. |
| V. NYSSACEAE
ALANGIACEAE | 1. <i>Nyssa javanica</i> (Bl.) Wang.
2. <i>Alangium begoniifolium</i> (Roxb.) Baill. |
| VI. ARALIACEAE | <i>Hedera himalaica</i> Tobler |
| VII. SALICACEAE | 1. <i>Salix daphnoides</i> Vill.
2. <i>Populus ciliata</i> Wall |
| VIII. FAGACEAE | 1. <i>Quercus lanuginosa</i> D. Don
2. <i>Castanopsis armata</i> Spach |
| IX. CASUARINACEAE | <i>Casuarina equisetifolia</i> Forst. |
| X. MORACEAE | 1. <i>Morus alba</i> Linn. and <i>Morus nigra</i> Linn.
2. <i>Cannabis sativa</i> Linn. |
| CANNABINACEAE | |
| XI. FLACOURTIACEAE | <i>Hydnocarpus anthelmintica</i> Pierre |
| XII. TILIACEAE | 1. <i>Grewia hainesiana</i> Hole
2. <i>Pentace burmanica</i> Kurz |
| XIII. ELAEOCARPACEAE | 1. <i>Elaeocarpus ganitrus</i> Roxb.
2. <i>Sloanea assamica</i> Rehd. et Wils. (<i>Echinocarpus assamicus</i> Benth.) |
| XIV. BOMBACACEAE | 1. <i>Salmaalma malabarica</i> Schott. et Endl. (<i>Bombax malabaricum</i> DC.)
2. <i>Hibiscus rosa-sinensis</i> Linn. |
| MALVACEAE | |
| XV. EUPHORBIACEAE | 1. <i>Ricinus communis</i> Linn.
2. <i>Euphorbia hypericifolia</i> Linn. |

3. *Bischofia javanica* Bl.
 4. *Chaetocarpus castanocarpus* (Roxb.) Thw.
 5. *Excoecaria agallocha* Linn.
- XVI. AQUIFOLIACEAE *Ilex dipyrena* Wall.
- XVII. OLACACEAE
1. *Erythropalum scandens* Bl.
 2. *Anacalosa densiflora* Bedd.
- XVIII. MYRSINACEAE
1. *Aegiceras corniculatum* (Linn.) Blanco
 2. *Ardisia humilis* Vahl and *Ardisia solanacea* Roxb.
- XIX. SAPOTACEAE
1. *Madhuca latifolia* (Roxb.) Mcbr. (*Bassia latifolia* Roxb.)
 2. *Mimusops elengi* Linn.
- XX. RHAMNACEAE
1. *Ventilago calyculata* Tul.
 2. *Zizyphus oxyphylla* Edgew.
- XXI. RUTACEAE
1. *Murraya koenigii* Spreng.
 2. *Micromelum pubescens* Bl.
- XXII. SIMARUBACEAE
1. *Ailanthus glandulosa* Desf.
 2. *Samadera indica* Gaertn.
 3. *Picrasma javanica* Bl.
- XXIII. BURSERACEAE
1. *Protium serratum* Engl. (*Bursera serrata* Colebr.)
 2. *Canarium bengalense* Roxb.
- XXIV. MELIACEAE
1. *Melia azaderach* Linn. The Persian Lilac
 2. *Cedrela toona* Roxb.
- XXV. SAPINDACEAE
1. *Sapindus detergens* Roxb.
 2. *Aesculus indica* Colebr.
- XXVI. ACERACEAE
1. *Acer oblongum* Wall.
 2. *Acer caesium* Wall.
 3. Diagram of *Acer pseudo-platanus* Linn.
- XXVII. ANACARDIACEAE
1. *Mangifera indica* Linn.
 2. Anacardiaceous fruits
- XXVIII. EHRETIACEAE
1. *Cordia dichotoma* Forst.
 2. *Ehretia laevis* Roxb.
- XXIX. OLEACEAE
1. *Jasminum pubescens* Willd.
 2. *Nyctanthes arbor-tristis* Linn.
- XXX. LYTHRACEAE
1. *Woodfordia fruticosa* (Linn.) Kurz
 2. *Lagerstroemia speciosa* Pers.
- XXXI. SOLANACEAE *Solanum nigrum* Linn.

PREFACE

If it be taken as axiomatic that forest officers and all those whose business it is to study vegetation should know how to identify the numerous species in their forests and in the countryside, then it is essential that they should know at least the elements of systematic botany. The acquisition of knowledge is never easy, but it becomes less of a burden if it is taught in an interesting and attractive way. Most people regard systematic botany as dull, but there is no reason why it should be. After all, it deals with objects which are alive and which exhibit the infinite variety of life—surely a matter of the deepest interest to all thinking persons. No, the reason for the 'dryness' of the subject lies in its presentation.

Most courses in systematic botany today start off with morphology. It is indeed unfortunate that botanical terms as used in English textbooks and botanical literature are, for the most part, based on Latin and Greek roots, so that the student is forced to learn a number of terms which to him have no obvious meaning. This cannot be helped, and the student must make the best of it.

After morphology comes the study of a limited number of families of plants. It is here that the study of systematics becomes so tedious for the student. Many teachers regard the characteristics of the families as so much information which must be learned by heart for examination purposes. It is just this useless effort which makes the vast majority of students recoil in disgust from botany after they have satisfied their examiners. It is not absolutely necessary for a student to know by heart how many stamens, sepals and petals are found in such and such a family, whether the ovary is superior or inferior, or what kind of placentation there is. He can find all this in his textbook. Even among professional botanists there are few, if any, who can rattle off the characteristics of all the families, and not many more can detail all the characteristics of even only a few. A professional botanist can, however, automatically place a plant in its family, or quite close to it. If he cannot do this, he dissects a flower and, by means of his keys and books, runs the plant to earth. Why shouldn't the student do the same thing and learn by experience?

The belief that there is no logical reason why the student should not do this is the reason for this book. If the student is taught, during his course of systematic botany, to use his books

to the best advantage, instead of learning by heart vast chunks of those books, he will know how to set about finding out the name of a plant after he has left the forest college, and not, as so many do, give it up in despair as something which only a professional botanist can do.

This book, which is meant for the student who has had his elementary course in botany, is the outcome of the course of lectures on Forest Botany delivered to students of the Indian Forest College at Dehra Dun, 1938-42. It is a book for the teacher and for the student, for use in the classroom as well as in the field, particularly on tour. It has been compiled in the belief that the more flowering material (living or preserved) the student handles, the sooner he will realize how easy it is to use keys for running down families and species. He will get to know families by experience and, if he has an aptitude for taxonomy, will acquire that flair which enables him to place a plant instinctively in the right family. Such gifts are not given to all, but practice can go a long way towards acquiring, if not infallibility, at least competence.

Once the family can be found the rest is easy.

Keys to the genera are given, and very often to the species of a genus. When known, bark and leaf characters are also described, for these are of great importance in the field. Uses to which the wood can be put, colour of latex, if any, and other interesting details are mentioned in the belief that if students can only be got to take an interest in their trees and shrubs during their period of study, they will maintain that interest throughout their professional lives. This book should not replace the local flora for which there will always be a demand; it is simply a *Manual of Indian Forest Botany*.

An attempt has been made to bring the nomenclature up to date, but there is little doubt that further research will alter some of the names. Not only will names alter as knowledge accumulates, but even our conception of the status and position of individual plants will be changed. One well-known Indian tree, *Nyctanthes arbor-tristis*, which has been regarded hitherto as a member of the *Oleaceae*, has recently been shown by my colleague, Mr Airy Shaw,¹ really to belong to the *Verbenaceae*. This discovery was made too late for inclusion in this book. Modern taxonomy is dynamic not static.

Anyone who writes a book on botany, nowadays, finds himself embarrassed when he comes to render thanks for the help he has received, and for all that has been done before, knowledge which he often accepts without question. It is quite impossible to mention every name, even if all were known, of those who have made contributions to a knowledge of Indian botany.

¹ *Kew Bulletin*, 1952, 271 (1952).

The writer is deeply indebted to all who have written local floras of India, many of them, one is proud to recall, former members of the Indian Forest Service. My friend, the Rev. H. Santapau, S.J., PH.D., F.L.S., etc., Rector of St Xavier's College, Bombay, has read the whole book in page proof, and corrected many errors. My former colleague, Shri M. B. Raizada, M.Sc., now Forest Botanist at Dehra Dun, gave me his assistance and advice when the lectures were originally prepared. My colleagues of the Royal Gardens, Kew, gave me their ready help in nomenclatural matters.

Most of the illustrations are adaptations from figures already published, and acknowledgement is due to the artist, Rai Sahib Ganga Singh. I am grateful to my wife, whose etching of evergreen hill forest near Kohima, Naga Hills, forms the frontispiece. This forest was destroyed in the fighting around Kohima in 1944.

Dr John Hutchinson, F.R.S., has been good enough to give the book his blessing by writing a foreword. Users of this book will be particularly grateful to him for allowing his key to the families of dicotyledons to be adapted for use in India.

Finally, I must pay tribute to the patience and skill of the Oxford University Press. The difficulties of publication in a situation in which the author and the Press are separated by several thousand miles are very great, and I am grateful to the Press for overcoming these difficulties with the minimum of trouble to myself.

It is my earnest hope that this book will help my young Indian friends to a better and deeper knowledge of the forests in their keeping—those forests which are such a great heritage and an equally great responsibility.

N. L. B.

Kew, 1953

ERRATA

Page	14, line 41	for <i>Melanorrhea</i> read <i>Melanorrhoea</i>
"	23, line 36	for Findl. read Endl.
"	52, line 26	for <i>macrocarpus</i> read <i>macrocarpum</i>
"	61, line 10	for <i>Delima</i> read <i>Dillenia</i>
"	86, line 14	for <i>Milletia</i> read <i>Millettia</i>
"	90, line 33	for <i>citratu</i> s read <i>flexuosus</i>
"	92, line 5	for Fawcett et Rendle read W. F. Wight
"	111, line 21	for <i>C. ciliata</i> read <i>P. ciliata</i>
"	144, line 34	for <i>cotandra</i> read <i>octandra</i>
"	166, line 38	for <i>coco</i> read <i>coca</i>
"	246, line 26	for <i>Zanthoxylon</i> read <i>Zanthoxylum</i>
"	257, line 21	for <i>Heynea</i> Roxb. read <i>Heynea trijuga</i> Roxb.
"	300, line 24	} for <i>Sphenodesma</i> read <i>Sphenodesme</i>
"	307, line 21	
"	362, line 22	for <i>zibethina</i> read <i>zibethinus</i>
"	364, line 43	for <i>Spathololus</i> read <i>Spatholobus</i>
"	368, line 15	for <i>Mezeneurum</i> read <i>Mezoneuron</i>
"	371, line 14	for <i>Petraeu</i> read <i>Petrea</i>

THE VEGETABLE KINGDOM

THE vegetable kingdom is divided into Cryptogams, in which there are no true flowers producing seed, and Phanerogams, in which the plants develop flowers or flower-like structures in which seeds are produced.

The Cryptogams are again subdivided into *Thallophyta*, *Bryophyta* and *Pteridophyta*.

Thallophyta are plants which possess a thallus or plant-body which is not differentiated into stem and leaves. To this group belong the *Algae*, *Diatoms*, *Fungi*, *Bacteria* and *Lichenes*.

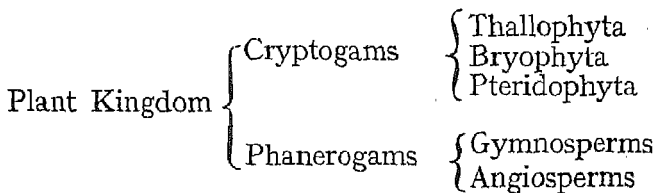
Bryophyta include the liverworts and true mosses which are distinguished from the *Thallophyta* by the possession of female reproductive organs, known as archegonia, and also by the fact that the plant body is not infrequently differentiated into stem and leaves. *Thallophyta* and *Bryophyta* are not of any great importance to the forest officer.

Pteridophyta are the fern-like plants. These plants possess vascular strands and there is often marked differentiation into stem and leaves (*Alsophila*), the latter being often of very large size and much divided. The female reproductive organs, the archegonia, are similar to those developed in the *Bryophyta*. In addition to the true ferns this group also includes the horse-tails (*Equisetum* spp.) and the Clubmosses (*Lycopodium* spp.).

The Phanerogams include all higher plants and by this is meant all present-day groups which exhibit the highest development and which are usually referred to as the *Spermatophyta*. This group is again subdivided into two phyla, namely, the Gymnosperms and the Angiosperms.

In the Gymnosperms the male and female reproductive organs are not contained in the same flower and the ovules are borne naked on the carpels which usually take the form of scales. On the other hand, in the Angiosperms the ovules are contained in a closed vessel, the ovary, and the male and female elements are usually, but not always, associated in the same flower.

The classification so far can be shown diagrammatically thus :



CRYPTOGAMS

Some remarks have already been made about the *Thallophyta* and the *Bryophyta* and it has been said that they are not of much importance to the forest officer. That statement must be qualified because these two groups are of the very highest importance from the point of view of succession, colonization and so on. Very often the first colonizers of bare places are *algae*, *lichenes* and other primitive pioneers and it is these lowly plants which prepare the way for the invasion of the higher type of plant. *Algae* and *Thallophytes* generally, insignificant though they may be individually, in the mass have a very powerful influence. They can secrete special ferments and acids which enable them to lay hold of bare rock and extract nourishment from it. They eventually build up a soil which contains plant-food in easily assimilable form and it is at this point, when conditions have been made easier by the lowly colonizers, that the higher plants can come in.

Of the *Cryptogams*, however, one group, the *Pteridophyta*, will certainly be noticed by the forest officer as members of it often form a gregarious covering of the soil. This group occupies a middle position between the more aquatic *Thallophyta* and the essentially terrestrial *Phanerogams* or *Spermatophyta*, and is therefore considered to occupy a unique stage in the evolutionary progress of plant life from the aquatic to the terrestrial habitat.

The geological history of the group is very ancient, for fossil remains of the ferns have been found in the Devonian strata. They were present in great numbers and in many forms when the coal-beds were laid down, and they extend into modern times in great profusion. They appear as terrestrial and epiphytic plants and their range, from the equator to the arctic, shows how well they have adapted themselves to changing climates and conditions in their long history.

The majority of the ferns are herbaceous and are exceedingly numerous in the tropics, where the ground flora in certain conditions consists almost entirely of ferns. The common bracken of Europe, *Pteridium aquilinum*, often covers large areas in the Himalayas at the higher altitudes. There is, however, one family of ferns which consists almost entirely of tree species and as this family is well represented in India, it is essential for forest officers to know something of them.

The family *Cyatheaceae* contains the tree-ferns and is itself contained in the subclass *Leptosporangiateae*. The stem of the tree-ferns is woody and unbranched and is attached to the soil by numerous adventitious roots. At the apex of the stem is to be found a rosette of circinate folded bipinnate leaves or fronds which are produced in succession from the apical bud,

and which leave, as they die, large scars on the trunk. The sporangia are produced in large numbers on the under-surface of the leaves and each group is covered over with an indusium which is more or less complete. As students will have learnt in their elementary botany, a very distinct alternation of generations is exhibited by the ferns. The plant recognized as the fern is actually the asexual form known as the sporophyte. The sporangia on the lower surface of the frond produce the spores.

The spores are carried about by the wind and come to rest on the soil. If the situation is favourable the spore germinates and gives rise to the sexual form known as the prothallium or gametophyte. Antheridia and archegonia are produced on the prothallium, which is never of any great size being at most a few centimetres long. The antheridia release numerous, usually spiral, motile spermatozoids, one of which fertilizes the single egg in the archegonium. The egg cell after fertilization develops into the fern-plant or sporophyte.

PHANEROGAMS

PHYLUM I

GYMNOSPERMAE

THE geological history of the Gymnosperms covers an enormous span of time which, according to some authorities, reaches back into the remote past some two to three hundred million years. Actually the first time we get a glimpse of them in the fossil record the remains can be subdivided into two great groups: the *Cycadophytes* and the *Coniferophytes*. Whether these two groups had a common origin or not, is not known. The *Cycadophytes* were comparatively small plants and had pinnate leaves and unbranched stems, large pith, little wood, thick cortex. The *Coniferophytes* were large trees with branches and simple leaves, small pith, abundant wood, thin cortex. Another group, the *Gnetales*, first appears in the Eocene quite distinct from the other two.

The *Cycadophytes* can be subdivided into three orders:

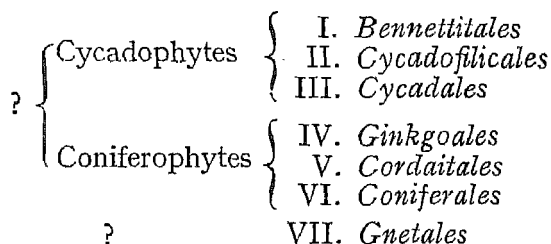
- 1) *Bennettitales*
- 2) *Cycadofilicales*
- 3) *Cycadales*

The *Coniferophytes* can also be subdivided into three orders:

- 4) *Ginkgoales*
- 5) *Cordaitales*
- 6) *Coniferales*

These six orders with the *Gnetales* make the seven orders of the Gymnosperms. Of these orders three are wholly extinct at the present day. They are *Bennettitales*, *Cycadofilicales* and *Cordaitales*.

The classification so far can be represented diagrammatically thus:



The characteristics of these orders are as follows:

I. *Bennettitales*. The male sporophylls are frond-like and form a loose crown. The female sporophylls are no longer leaf-like but are found in a very specialized cone-like structure.

II. *Cycadofilicales*. Both the male and female sporophylls are frond-like leaves more or less modified but never form a cone.

III. *Cycadales*. Here the male and female sporophylls are grouped into cones, except in the genus *Cycas* where the female sporophylls are collected into a loose crown like the male sporophylls of *Bennettitales*. Leaves pinnate.

IV. *Ginkgoales*. Here the leaves are flattened and lobed in various ways, with dichotomous venation. The male and female elements are collected into cones. The spermatozoids are motile.

V. *Cordaitales*. These large trees have flat strap-shaped leaves. Male and female elements in cones.

VI. *Coniferales*. This order has leaves which are either needle- or scale-like, sometimes flattened, but the male cells are never motile. Male and female elements arranged in cones.

VII. *Gnetales*. Opposite leaves, dicotyledonous embryos, compound cones in both male and female are the characteristics of this order.

I. BENNETTITALES

This order appears in the Upper Carboniferous and dies out about the middle of the Cretaceous. The plants contained within it are of interest to taxonomists because of the fact that the female cones were of a very special form. The embryos were dicotyledonous and a very plausible theory was built up by Arber and Parkin in an endeavour to connect the *Magnoliales* with the *Bennettitales* through a common ancestor. These two authors make out a very logical case which deserves serious consideration, but no trace of the hypothetical ancestor of both groups has ever been found and it is certain that the *Bennettitales* left no progeny, so that this order cannot be the ancestor of the Angiosperms.

II. CYCADOFILICALES

This order reached its greatest development in the Upper Carboniferous and the great profusion of its species has given the name 'Age of Ferns', to this period, but it began to decline in the Permian and disappeared altogether in the Lower Jurassic. The members of this order have a striking resemblance to ferns in their foliage and it is only natural to assume that they have descended from the true ferns. The great stumbling-block of course has been to imagine how the seed evolved from

the spore. One school of thought connects the *Cycadofilicales* with homosporous ferns through the heterosporous ferns.

III. CYCADALES

This order contains only one family, *Cycadaceae*. The only genus found in India is *Cycas* Linn. This genus consists of small trees which are often mistaken for palms. The trunks are annulate or covered with the woody bases of the petioles of the terminal crown of leaves. The leaves are pinnate with linear entire coriaceous stiff and pungent leaflets. The flowers are dioecious and are found at the apex of the trunk concealed at first among the bases of the leaves. The male flowers are in erect cones, sometimes two together, consisting of many closely imbricate cuneate scales which are usually produced into a long acuminate point. On the under-surface of these scales are to be found very many globose anther-loculi. The macrosporophylls are found in crowded cone-like whorls at the tip of the trunk. They are densely woolly and are at first loosely imbricate, finally spreading. The large naked orthotropous ovules are borne on the flat stalk of the macrosporophyll which is dilated into a leaf-like structure at the distal end. The fertilization takes place through motile spermatozoids. The seed is large and the embryo is buried in a copious endosperm.

Apart from the flowers the fact that the trunk shows secondary thickening is quite sufficient to separate cycads from the monocotyledonous palms. Mucilage ducts are present in all parts of the plant. The vascular bundles are collateral but the xylem consists of tracheids only.

There are about four species found in India, which can be easily distinguished by the following key.

Margins of leaflets revolute:

Small palm-like tree ... *C. revoluta*

Small shrubs, stem only a few inches high ... *C. beddomei*

Margins of the leaflets flat:

Leaflets narrow, not more than 0.3 in. broad ... *C. siamensis*

Leaflets about 0.5 in. across ... *C. circinalis*

C. revoluta Thunb. This species is a native of China and Japan but is widely cultivated in India in gardens where it can easily be distinguished from other species by the revolute margins of the pinnae. The trunk contains a sago and the fruits can be eaten, being rich in protein and soluble non-nitrogenous substances. The leaves, after silvering and treatment in various ways, are made into funeral wreaths in Europe, where the leaves are called palm-leaves.

C. beddomei Dyer. This small shrub is found only in the hills of the Cuddapah District in Madras State.

C. siamensis Miq., a small tree found in Burma, is extremely close to *C. pectinata* Griff. which grows in the plains and hills of eastern Assam. Burkill considers that the one is only a geographical race of the other. The hill-tribes of Assam eat the seeds, and the tender fleshy shoots are also prized as a vegetable.

C. circinalis Linn. This plant is found in southern India and Ceylon, mostly in dry deciduous forests, and reaches a height of 25 ft. in favourable localities. The leaves are used for making mats in south India, but the seeds and also the young shoots can be eaten, while sago can be obtained from the stem. The seeds are said to be poisonous in the uncooked state, but the poison can be eliminated by pounding and repeated washings in water. The poisonous substance is pakoein and with it is associated a cholesterolin-like substance, phytosterine, which is also said to be toxic (Burkill).

A tree is said to be ready to provide sago at the age of seven years and the best time to obtain this food is before the new flush of leaves is produced. The plant is felled and the trunk cut up into disks which when dry are pounded into a flour and then thrown into water, where the starch settles down. It has been found that this species gives annually as much starch in its seeds as can be obtained by destroying the plant and harvesting the pith.

IV. GINKGOALES

There is only one survivor in the world today of this very ancient order. This straggler is the Maidenhair-tree, *Ginkgo biloba* Linn., so called because the leaves resemble in their venation and shape those of the maidenhair ferns, *Adiantum* spp. It is possible that there may be a few truly wild specimens of this tree in China but the survival of this living fossil is assured, because it is preserved around Chinese temples and is considered to be a valuable addition to botanical gardens. The trees are dioecious and under very favourable conditions may reach a height close on 100 ft. but are usually much smaller than this. The male inflorescence or cone consists of a number of stamens loosely disposed around a central axis. The female cone takes the form of two naked ovules at the apex of a peduncle. As in the Cycads, fertilization is accomplished by the production of motile, free-swimming spermatozoids.

Ginkgo is intermediate in character between the Cycads and the Conifers.

V. CORDAITALES

The members of this group were large trees and probably formed the world's first great forests, for they grew in dense stands and reached 100 ft. in height with a girth of 9 ft. A

forest of such trees by even modern standards must have been a fine sight. The *Cordaitales* were in full swing in the Carboniferous but they declined in the Permian and died away soon afterwards.

VI. CONIFERALES

Mostly evergreen trees with branched stems, rarely shrubs. Wood without vessels, consisting of long tracheids which show bordered pits at the medullary rays, frequently with resin-canals. Needles usually evergreen, rarely falling in autumn (*Larix*, *Taxodium*), entire, spiral or distichous or whorled, solitary or in fascicles, often awl- or scale-like. Flowers monoecious or dioecious (*Juniperus*, *Taxus*); the male terminal or lateral and then surrounded by supporting bracts; stamens small, many, with 6-15 pollen-sacs; connective often produced as an appendage. Female flowers collected in cones or catkins, rarely solitary, usually many, rarely few (*Taxaceae*), each consisting of a bract and a scale, the latter immediately above the former, both these structures being usually distinguishable. The female inflorescence ripens in one or two or more years to a cone, which is usually dry (strobilus), or fleshy in *Juniperus* (galbulus), seldom seed-like and surrounded with an aril (*Taxaceae*). Seeds often winged, nut-like in a leathery or woody shell. Cotyledons 2-16.

This order is well represented in India, especially in the north and east, for, strangely enough, only one conifer, *Podocarpus wallichianus* Presl, is found in Madras State. The order is divided up into the following families (only those indigenous in India and Burma are mentioned):

FAMILY	GENERA
I. <i>Taxaceae</i>	<i>Taxus</i>
II. <i>Podocarpaceae</i>	<i>Podocarpus</i>
III. <i>Cephalotaxaceae</i>	<i>Cephalotaxus</i>
IV. <i>Pinaceae</i>	1. <i>Tsuga</i> 2. <i>Abies</i> 3. <i>Picea</i> 4. <i>Cedrus</i> 5. <i>Pinus</i> 6. <i>Larix</i>
V. <i>Taxodiaceae</i>	1. <i>Taxodium</i> 2. <i>Cryptomeria</i> 3. <i>Taiwania</i>
VI. <i>Cupressaceae</i>	1. <i>Cupressus</i> 2. <i>Juniperus</i>

I. TAXACEAE

Slow growing, long lived, evergreen trees with flat evergreen linear distichous leaves without a resin-canal (see *Cephalotaxus*). Flowers dioecious on short axillary branchlets which are densely clothed with imbricating scales. Male flowers single or in catkins; stamens numerous, naked, arranged along the axis of a catkin; filaments of peltate scales, each of which bears on the under-surface 3-6 anthers, 2-8-locular, dehiscing longitudinally. Female flowers solitary, seated in a cupuliform disk which is accrescent. Fruit composed of an erect bony seed surrounded by a fleshy red arillus.

Taxus Linn. *Taxus baccata* Linn. The Yew tree. An evergreen shrub or tree which sometimes reaches a great age and very large proportions. It has distichous flat dark-green leaves and a reddish-brown thin bark. This tree is found in the Himalayas, Khasi and Naga Hills and on the hills of Burma above 6,000 ft., in the evergreen and coniferous forests.

The leaves contain an alkaloid poison which is fatal to livestock. The poison content, however, varies very considerably from place to place and may be quite absent, for the tree is extensively lopped in parts of the Himalayas as a fodder for stock. The wood is tough and elastic but is hardly used in India.

II. PODOCARPACEAE

Evergreen shrubs or large trees with elliptic-lanceolate, linear-lanceolate or elliptic leaves which are usually spirally arranged but sometimes two-ranked as in *Abies*, and varying in size from small scales to a foot long; young leaves often rose or red in colour. Flowers usually dioecious. Male flowers cylindrical, dense, catkin-like, axillary or terminal; stamens numerous with short filaments; pollen grains with two large wings. Female flowers stalked or sessile, axillary or terminal, with usually 2-4 (occasionally more) scales, one or two of which bear in their axils a fertile scale (epimatium) folded over and united to an inverted ovule; usually only one matures, the sterile ovule often fusing with the upper part of the stalk and developing into a swollen, fleshy, brightly coloured, edible receptacle, upon which the seed is borne. Seed round or ovoid, with an outer fleshy or skinny (the epimatium) seed-coat and with an inner woody shell.

The only genus of this family found in India is *Podocarpus* L'Héritier, which is represented by three species.

The following key distinguishes them:

Leaves not more than 1 in. long	...	<i>P. imbricatus</i>
Leaves much longer, 4-7 in. long:		
Leaves linear	...	<i>P. neriifolius</i>
Leaves elliptic	...	<i>P. wallichianus</i>

P. imbricatus R. Br. (*P. cupressinus* R. Br.) This species reaches a height of 80 ft. in Burma and is an important timber-tree there. It has leaves of two kinds: those of young and vigorous trees, 0.25-0.5 in. long, flat, soft, and arranged in two, more or less opposite, ranks; those on the twigs of older trees very short and closely overlapping like those of a *Cupressus*, the points being incurved like miniature leaves of *Cryptomeria japonica*. Both types of leaves may appear on the same tree, but in such cases those of the juvenile state are smaller than those on young vigorous plants.

P. nerifolius D. Don. This species is a large evergreen tree with whorled branches and linear leathery leaves up to 10 in. long, the leaves on young trees being longer than those on older trees. A variety, known as var. *brevifolius* Stapf, has been described as being found in the Himalayas, Khasi Hills and elsewhere in eastern India. The type of the species is found in the foot-hills of the Himalayas, Khasi and Naga Hills, hills of Burma and in the Andaman Islands, from the plains up to 3,000 ft. It is typically an inhabitant of the evergreen climax forests of those parts. The timber is of a light colour and is prized for general carpentry work. According to Pearson, it is a very high class timber and he considers that the tree should be extensively cultivated.

P. wallichianus Presl (*P. latifolia* Wall.) is a tall, evergreen, glabrous tree found in Assam, Martaban, Tenasserim and in the Western Ghats from the Nilgiris southwards. It is the only conifer of the Indian Peninsula. The wood is said to be grey, aromatic and moderately hard. The leaves in this species are much broader than in the other two.

III. CEPHALOTAXACEAE

Shrubs or small dioecious trees with linear flat distichous alternate leaves (leaves very similar to those of *Taxus* but easily distinguished by the presence of a large resin-canal on the lower side between the midrib and the epidermis). Male flowers 6-11, forming globose heads in the axils of membranous bracts and supported by a small involucre of imbricating scales. Single flowers of 7-12 stamens, each consisting of a stipitate scale bearing on its back 2-3 anther loculi; pollen grains globose. Female flowers arranged in small pedunculate cones, several of which are found in the axils of bracts at the base of terminal shoots, which lengthen out after the flowers have been fertilized. Scales 6-20 on the fleshy axis of the cone, each with two ovules at the base, only one of which develops. At a later stage the scales become fleshy and often confluent, so that the immature seeds appear as if enclosed in fleshy cups. Seeds large, usually one or two only in each cone; testa fleshy, resinous, with a thin, inner, woody layer.

Cephalotaxus. There are two species in India, both of which are found in Assam.

The following key distinguishes them.

- | | |
|----------------------------------|--------------------------|
| Leaves narrowed at the base | ... <i>C. mannii</i> |
| Leaves with a broad rounded base | ... <i>C. griffithii</i> |

C. mannii Hook. f. and *C. griffithii* Hook. f. are small evergreen trees found in the upper evergreen hill-forests of the Khasi and Naga Hills as well as in the evergreen forests of the eastern Himalayas. Their timber does not appear to be used. The former species has been introduced into Europe where it does very well, particularly so in the Rhine Valley.

IV. PINACEAE

A large family comprising resinous trees which are often gigantic in size with mostly whorled branches. Leaves evergreen (deciduous in *Larix*), stiff, acicular, subulate, narrowly linear, distichous or arranged in 1-7-foliate fascicles, girt at the base by a scarious sheath. Flowers monoecious; stamens and ovuliferous scales spirally arranged round a common axis, forming terminal or lateral catkins and cones respectively. Stamens numerous, each with two anthers, naked, compact; filaments very short; pollen with two wings. Female flowers: ovuliferous scales usually numerous, accrescent; ovules two, collateral. Fruit a woody cone, persistent or shedding the woody scales. Seeds two, collateral, usually winged. Cotyledons 3-18. Seed with endosperm.

The genera found in India are the following: *Pinus*, *Picea*, *Tsuga*, *Abies*, *Cedrus* and *Larix*, which can be easily separated by means of the following key.

Leaves evergreen:

- | | |
|---|---------------------|
| Cones pendulous, woody, persistent: | |
| Leaves acicular, in bundles | ... 1. <i>Pinus</i> |
| Leaves not acicular and not in bundles: | |
| Cone globose, not more than 1 in. long | ... 2. <i>Tsuga</i> |
| Cone several inches long, cigar-shaped | ... 3. <i>Picea</i> |
| Cones erect, breaking up on the tree, leaving a central axis: | |
| Leaves distichous | 4. <i>Abies</i> |
| Leaves in tufts on tips of arrested branches | 5. <i>Cedrus</i> |
| Leaves deciduous | ... 6. <i>Larix</i> |

1. *Pinus* Linn. In the pine the flowers are monoecious. The male flowers, which fall away shortly after the pollen is shed, are catkin-like but erect, seated in the axils of membranous bracts which are spirally arranged on an axis. The young cones, or female inflorescences are solitary, paired or whorled at the apex of the current year's shoot, and consist of a central woody axis upon which are arranged in spiral fashion two sets of scales.

One of the outer bracts disappears before the cone ripens. The larger of the scales is the ovuliferous scale and bears two ovules. Pollination takes place in the first year just after the flowers open. After pollination the scales close but the pollen-tube does not reach the embryo-sac until the beginning of the second year. The fruit is a woody cone of spirally arranged scales. The exposed portion of the scale in the cone is called the apophysis, and the scar on it is known as the umbo. Germination is epigeous. Cotyledons in Indian species 6-13.

A very large genus of resinous trees of which five species are found in India though many more have been introduced.

The following is a key to the Indian species.

Leaves in fascicles of 5 ... *P. wallichiana*

Leaves in fascicles of less than 5:

Leaves 3 in a fascicle:

Leaves stiff, less than 6 in. long ... *P. gerardiana*

Leaves soft, more than 6 in. long:

Wings four times as long as the seed, umbo of the scales without a prominent beak ... *P. insularis*

Wings about the length of the seed; umbo of the scales with a prominent hooked beak ... *P. roxburghii*

Leaves only 2 in a fascicle ... *P. merkusii*

P. wallichiana A. B. Jacks. (*P. excelsa* Wall.) The Blue Pine. This species is a large evergreen tree with a glaucous foliage, reaching a height of 165 ft. in favourable places. It is found growing gregariously all along the Himalayas in temperate climates (between 6,000 and 10,000 ft.). Troup says that most of the important blue pine forests are situated in regions where the rainfall varies from 45 to 75 in.

In the Apa Tanang country in the eastern Himalayas the tree enjoys a rainfall of approximately 200 in., while in the Sulaiman range it is found tolerating a rainfall of probably less than 10 in. in the year. These figures show what an accommodating species this pine is and this estimate is corroborated by the fact that its altitudinal range is from 4,000 to 12,000 ft. The glaucous foliage, the needles in bundles of five and the shape of the cone are quite sufficient to separate this species from the other pines in India. The ripe cones are pendulous, cylindrical in shape, without any pronounced beak on the apophysis.

P. gerardiana Wall. The Chilgoza Pine. An evergreen tree, occasionally reaching a height of 80 ft. but usually much smaller. It is found in the north-west Himalayas where the rainfall is scanty but winter snowfall heavy. It makes little demands on the soil and seems to thrive where no other trees can. As a timber it is not prized, but it is important on account of its edible seeds which are roasted and eaten. Large quantities of the seeds

are collected for export to the plains. The wing of the seed is small and deciduous.

P. insularis Endl. (*P. khasya* Royle). The Khasi Pine. A large evergreen tree with whorled branches and rounded crown, reaching a height of 100 ft. in favourable localities, found in the Khasi and Naga Hills, Manipur, Upper Burma and the Philippine Islands. It has been shown that the pure pine forests of these areas cannot be considered a climax forest as they turn to evergreen when fire is excluded. The seeds of this pine are unable to germinate and grow in areas protected from fire, but profuse natural regeneration is obtained if the layer of pine needles is burnt off.

Its spread has been greatly helped in the areas mentioned by the system of shifting cultivation practised by the hill-tribes. The wood is moderately hard and is extensively used in the Khasi Hills for building purposes. In Burma it is not much used. In both Assam and Burma it is greatly prized as torch-wood, the production of which usually kills the tree. The bark and outer wood are sliced off the bole in order to induce a flow of resin. The resin-impregnated wood is constantly removed so that eventually the base of the tree is almost cut through and it dies or is blown down. The resin produced by this species is of a very high quality, but the inaccessibility of the forests has prevented them being worked for this purpose.

P. roxburghii Sarg. (*Pinus longifolia* Roxb.). The Chir Pine. An evergreen tree found all along the Himalayas, 1,500-7,500 ft., from the Dacca country to Afghanistan. It forms pure forests of very considerable extent and is the principal source of Indian resin which is only slightly inferior to that obtained from *P. insularis* and *P. merkusii*. Under favourable conditions this pine reaches 180 ft. with a girth of 10 ft. These figures are, however, very exceptional and trees above 100 ft. are rare. The needles in fascicles of three and the cone with a prominent beak on the back of the scales are characters which distinguish this pine from others.

P. merkusii Jungh. The Tenasserim Pine. This is a small evergreen tree found in Burma and Malaysia. It hardly reaches 10 ft. in Burma, but is said to grow to 100 ft. in Sumatra. It is a true tropical pine for it is found as low as 500 ft. on low hills and its associates are the typical tropical genera *Dipterocarpus*, *Pentacme*, *Shorea*, *Melanorrhæa*. The resin produced by this tree is of superior quality.

2. *Tsuga* Carrière. There is only one species of this genus, *T. brunoniana* Carr., found in India. The hemlocks are evergreen trees with linear needles, arranged in distichous rows on the twigs, with a knee-shaped stalk seated on a tuberculate cushion. There is a solitary resin-canal below the midrib. The flowers are monoecious. The male flowers are borne singly in

the axils of the leaves of the previous year and consist of many stamens in the axils of overlapping scales. The female flowers are found in cones which are borne at the tip of the lateral shoots of the previous year. The ovuliferous scales are rounded and are somewhat longer than the supporting bract. Fertilization takes place in the first season and the cones are ripe within the year. The small rounded pendulous cones, however, remain upon the branches for a year or two. It is a stately evergreen tree of high altitudes (8,000-10,000 ft.) in the Himalayas, extending from Kumaon to the Mishmi country in the east, where it is associated with rhododendrons, spruce and firs. The wood is not considered to be of any use. The tree reaches a height of 120 ft. in favourable localities. Easily distinguished from other conifers by the small globular cone.

3. *Picea* Dietrich. The spruces are tall evergreen trees. The leaves are flat or quadrangular in section, needle-shaped, seated on stalks which remain after the fall of the leaf and are arranged spirally on the shoot. Flowers monoecious, appearing in spring on different branches in the leaf-axils of the previous year's shoots. Male flowers catkin-like, usually solitary, consisting of numerous overlapping antheriferous scales. Each scale with two linear pollen-sacs attached to the margins; pollen-grain with two inflated wings. Female flowers solitary at the tips of the twigs of the previous year. Ovuliferous scales numerous, wide, much longer than the supporting scales; two ovules at the base of each scale. Cones pendulous, ripening in the first season. After the seed is shed the cones remain for some time upon the tree. The seed has a well developed wing.

There are two species of spruce in India which can easily be distinguished from each other by means of the following key. Spruces are easily separated from other conifers by the presence of peg-like leaf-bases on the twigs.

Needles quadrangular in section	... <i>P. smithiana</i>
Needles flat in section	... <i>P. spinulosa</i>

P. smithiana Boiss. (*P. morinda* Link). A very large evergreen tree of the north and north-west Himalayas. Heights of 200 ft. or over are quite common and these heights are accompanied by a girth of as much as 19 ft. It is found between 7,000 and 11,000 ft. from Afghanistan to Kumaon.

A spruce collected in Burma on the Fenshuiling Pass, Myitkyina district, was for long thought to be this species but it has the flattened needles of *P. spinulosa* Beiss. It seems, therefore, that this spruce is confined to the north-western Himalayas and probably is not found east of Nepal. It grows gregariously in its habitat but is not found pure over large areas. It is often associated with silver firs and oaks.

The wood is suitable for matches and wood-pulp and is also

used for shingles, tea-boxes and planking. Old trees frequently exhibit a mass of brown wood, simulating heartwood, in the lower part of the stem. When exposed to the air it forms small cubes as it dries and falls away. The formation of this brown wood is due to a fungus, *Trametes pini*.

P. spinulosa Beissner (*P. morindoides* Rehd.). This evergreen is found in Sikkim and Bhutan and eastwards into the Mishmi Hills and probably into Burma as well, being found between 8,500 and 11,000 ft. It rarely reaches a height of 50 ft. but Troup mentions some evidence which indicates that in certain localities it can grow much larger.

4. *Abies* Linn. A genus of evergreen trees. The leaves are variously arranged on the shoots, those on the lateral shoots being pectinate or spreading all round, or imbricate, pointing forwards. On leading shoots they spread widely. The leaves are linear-oblong, often emarginate, flat, usually marked below by two waxy stomatal bands. When the leaves fall they leave behind circular disk-like scars. Flowers monoecious. The male flowers sessile in the axils of the leaves on the lower side of the previous year's shoots, catkin-like, with many membranous bracts at the base; stamens spirally arranged, shortly stalked, with two globular pollen-sacs opening downward and with the central portion of the filament projecting into a head; pollen-grains with two inflated vesicles. Female flowers cone-like; ovuliferous scales spirally arranged, rounded without, narrowed to a stipe inside, carrying two ovules at the base; outer scales of supporting bracts often enlarging after flowering time and longer than the fertile scales but narrower. Cones erect, falling to pieces when still on the tree and leaving behind the erect spindle. Seeds with resin-vesicles and permanent wings.

There are four species of *Abies* found in the Himalayas. *A. pindrow* Spach, *A. spectabilis* Royle, *A. densa* Griff. and *A. delavayi* Franchet.

The first two of these species are found in the western Himalayas. According to Parker the two species can be distinguished in the field by habit:—Middle-aged trees of *A. spectabilis* have the branches more widely spreading than those of *A. pindrow* and consequently the crown is not so conical. In old trees of *A. spectabilis*, the tips of the branches are upcurved which together with the slightly broader crown distinguishes it from *A. pindrow*. In very old trees the original crown disappears and is replaced by short branches which arise from the main stem. This gives the old trees a very narrow crown, much narrower than the crown of *A. pindrow*, and should some of the original branches remain, a very ragged appearance. Parker goes on to say that in his opinion the two species hybridize rather freely and that, in consequence, it is not always possible to make a sharp distinction between them.

The other two firs occur in the eastern Himalayas.

The following is a key to the four species.

Crown narrowly cylindrical; branches short; carpellary scales or bracts hidden by the placental or cone scales and invisible till the cone breaks up; male catkins 0.5-0.7 in. long, ellipsoid:

Sterile shoots usually hairy when young, with the leaves 0.5-1 in. long, covering the shoots when viewed from above, distichous when viewed from below

A. spectabilis

Sterile shoots glabrous, with the leaves 1-2 in. long and arranged distichously when viewed either from above or below

... *A. pindrow*

Crown broadly pyramidal or flat; branches wide spreading; carpellary scales or bracts with long acuminate tips, or tips at least emerging from between the placental or cone scales:

Leaves up to 2.5 in. long; margins not recurved

A. densa

Leaves up to 1 in. long; margins recurved

A. delavayi

A. spectabilis Royle (*A. spectabilis* Spach; *A. webbiana* Lindl.). The species is locally known as the West-Himalayan high-level Silver Fir. It is very similar to the next species but is found at the upper limits of tree growth ascending to 14,000 ft. and found rarely below 11,000 ft. Uses of the wood as for the next species. It does not grow to such proportions as *A. pindrow* and is often stunted and gnarled at high altitudes.

A. pindrow Spach. The low-level Himalayan Fir. An evergreen tree which reaches very large dimensions—heights of 206 ft. and girths of 26 ft. having been recorded. It is usually found associated with *Picea smithiana* Boiss. (*P. morinda* Link) but sometimes occurs in pure stands or mixed with species of *Quercus*, *Acer*, *Aesculus*, *Prunus*, etc. Its altitudinal limits are 7,000-11,000 ft. and the tree does not occur east of Kumaon. The wood is soft and is suitable for matches and paper-pulp. *Trametes pini* often attacks this fir and the disease manifests itself in the formation of brown wood as in *Picea smithiana*.

A. densa Griff. The East Himalayan Fir. This evergreen tree often attains a height of 200 ft. It is found in Sikkim, Bhutan and eastwards into the Balipara Frontier Tract, between 9,000 and 15,000 ft. It is found growing gregariously and forms pure forests of considerable extent.

A. delavayi Franchet. As far as is known this fir is found only in one place in India, on the top of the Piri mountain, Balipara Frontier Tract, where it forms small pure stands. It was originally described from Szechuan, China.

5. *Cedrus* Link. A genus of large evergreen trees. Flowers

monoecious or dioecious. The male flowers are found solitary at the end of short shoots, catkin-like, but erect, stiff, consisting of numerous spirally arranged stamens, each with two adjacent pollen-sacs opening longitudinally; connective projecting as an expanded appendage, often egg-shaped or toothed; pollen without wings, golden. Female flowers in small greenish cones solitary at the tips of side shoots; ovuliferous scales numerous in many rows, spirally arranged, rounded exteriorly, tapering to a narrow claw; each with two ovules at the base; supporting bracts very small and concealed by the fertile scales. Cones large, erect, barrel-shaped, seated on a short stalk. Two seeds are found on each scale, attached to a large membranous apical wing several times longer than the seed. Cotyledons 9-10. The cones are fully mature two years after pollination and break up while on the branches. This last character separates the genus from *Larix* which it superficially resembles; in *Larix* the cones do not break up. Moreover the shape of the cones is quite different in the two genera. In *Cedrus* the cones are squat and cylindrical about 1.5-3.5 in. in diameter, erect on the branches. In *Larix* the cones are pendulous and much smaller.

Cedrus deodara Laws. A very large evergreen tree found in the western Himalayas between 4,000 and 11,000 ft., but most commonly from 6,000-8,500 ft. This tree reaches huge dimensions and it is in all likelihood our largest tree. According to Troup, Dr Schlich found one in the Sutlej Valley which was 240 ft. tall. Girths are on the same scale and one of 36 ft. is on record. The largest deodars are those which are planted near temples and which are venerated and protected from injury. The tree does not exist east of the Alaknanda river in Garhwal but extends westwards into Afghanistan. Deodar is typically gregarious and is usually to be found in pure stands. It is, however, often found in association with *Picea smithiana* and *Pinus wallichiana* (*P. excelsa*), but also, by no means infrequently, found associated with oaks, maples, cherries, chestnuts and other broad-leaved species of the temperate forests.

This is the most important timber-tree of the western Himalayas. The wood is extensively used for building and railway sleepers. It is very durable for a coniferous timber.

6. *Larix* Adanson. A genus of deciduous trees found in the northern hemisphere. Shoots of two kinds; long terminal shoots bearing needles spirally arranged and short secondary shoots which elongate very slowly and bear terminal tufts of leaves of unequal length. The leaves are flat and keeled beneath. Flowers monoecious. Male flowers globular, ovoid or oblong, composed of numerous stamens and enclosed at the base by brown fimbriate scales, solitary, terminal at the ends of thick side shoots; stamens spirally arranged, shortly stalked, with two

almost spherical pollen-sacs; connective lengthened into a short upright appendage; pollen without wings. Female flowers erect, cone-like, each in a circle of partially developed leaves surrounded by brown fringed scales, seated on short shoots, consisting of numerous spirally arranged ovuliferous scales (each with two ovules) supported by bracts, the latter often exceeding the fertile scales in length. Seeds small, with a definite wing.

Larix closely resembles *Cedrus* in branch and leaf arrangement. In *Cedrus* the leaves are evergreen and the cones break up on the branches, in *Larix* the leaves are deciduous and the cones hang for a long time on the branches.

L. griffithiana Carr. (*L. griffithii* Hook. f.). A deciduous tree of the eastern Himalayas, found in eastern Nepal, Sikkim, Bhutan and the Mishmi country at 8,000-12,000 ft. It reaches a height of only 60 ft. and is not of any great importance as a timber-tree.

V. TAXODIACEAE

Large trees with evergreen or deciduous leaves which are scale-like or needle- or sickle-shaped. Flowers monoecious; the male either terminal or lateral, forming heads or catkins; stamens with a short stalk with 2-8 free pollen-sacs hanging from the under-surface of the broadly expanded connective; anthers opening by longitudinal slits; pollen without wings. Female flowers solitary, terminal, surrounded at the base by an involucre consisting of spirally arranged scales of two kinds: fertile scales more or less adnate to the bracts, during flowering time present as bolster-like swellings, later on getting longer and overlapping the bracts, sometimes absent or inseparable from the bracts (*Taiwania*): ovules two, upright or inverted. Cone globose or ovoid; the leathery or woody scales springing open when ripe. Seeds dry with a woody shell, shortly winged. Cotyledons 2-9.

Taiwania Hayata is the only Indian genus of this family, but *Cryptomeria* and *Taxodium* are also widely planted.

These genera can be separated by the following key:

- | | | |
|---|-----|-----------------------|
| Side-shoots leafy, deciduous as a whole | ... | 1. <i>Taxodium</i> |
| Leaves and shoots not deciduous: | | |
| Fertile scales and bracts distinct | ... | 2. <i>Cryptomeria</i> |
| Fertile scales and bracts not distinct | ... | 3. <i>Taiwania</i> |

1. *Taxodium* Rich. The leaves are spirally arranged on the branches, but on the deciduous side-shoots the leaves appear two-ranked owing to a twist near the base. Flowers monoecious. Male flowers in purple slender tassel-like clusters, stalked, scaly at the base, consisting of 6-8 stamens. Female flowers terminal on branches of the preceding year, solitary or few together, consisting of numerous overlapping pointed bracts attached to

the fleshy scales below; scales with two ovules. Cones globular or ovoid; scales shield-like, tapering to a narrow stalk which breaks away when ripe. Seeds irregularly triangular with thick warty coats.

T. distichum Rich. is a semi-deciduous tree which grows to 100 ft. tall in its native home. On well-drained soil the trunk tapers from base to apex, but in swamps the well-known knees, which are woody structures several feet high and hollow, are developed. The var. *mucronatum* is sometimes given specific rank as *T. mucronatum* Tenore. According to Beissner it was generally thought that *Taxodium distichum* was the wood from which 'Braunkohle' was produced, but later researches have revealed that another coniferous species, which is most likely *Sequoia sempervirens*, was the principal species from which the material was formed.

The trees planted at Dehra Dun are extremely ornamental. The new foliage appears in spring and is of a delicate green colour, darkish-green in summer, fading to all shades of brown and red in autumn.

2. *Cryptomeria* Don. A very tall tree with drooping branches. Leaves spirally arranged, awl-shaped, 0.25-0.5 in. long, keeled on both surfaces. Flowers monoecious. Male flowers subterminal, in clusters of 20 or more from the axils of the leaves, consisting of closely arranged spiral subsessile stamens, each bearing 4-5 round anthers; connective expanded at the end into a 3-cornered scale. Female flowers terminal or on short side twigs, almost round, consisting of 20-30 spirally arranged scales and bracts; scales first of all appearing as small swellings between ovules and bracts, subsequently enlarging, attached to the bract for half its length; tip of bract sharply recurved; ovules 2-5, upright; scales with 2-3 curved processes at the apex. Seeds 2-5 on each cone, leathery and 2-3-angled.

C. japonica Don. has been grown on a considerable scale in the Darjeeling hills and less so in the Khasi Hills. In India the growth is extremely rapid and it is difficult to find a use for the very soft wood.

3. *Taiwania* Hayata. Evergreen trees. Male flowers in groups of 5-7, collected at the ends of short side-shoots, each consisting of about fifteen stamens standing at right angles to the axis; filaments filiform; connective expanded at the tip into an oval-toothed scale bearing at its base two free anthers. Female flowers in shortly cylindrical cones, each consisting of 12-20 scales, spirally arranged, leathery, with two basal ovules; bract not distinguishable from the scale. Seeds oblong, with a narrow wing. This is a monotypic genus.

T. cryptomerioides Hayata, first of all found in Formosa, was collected in Burma many years ago and was misidentified as *Juniperus recurva*. Specimens collected in 1939 by

Capt. Kingdon Ward were identified in the Botanical Branch, Forest Research Institute, as *T. cryptomerioides*, and fixed the identity of the Chinese coffin-tree. This tree grows on the north-east frontier of Burma and from that place the boards are exported at the expense of considerable labour to China, where they command a very high price. It reaches an enormous size in Formosa where it runs up to 200 ft. In foliage it is extremely like *Cryptomeria* but in the cone it has close affinities with the genus *Cunninghamia*.

VI. CUPRESSACEAE

This family comprises evergreen, usually much-branched, trees or shrubs with scaly or needle-shaped, opposite or whorled leaves. Flowers monoecious or dioecious, terminal on short twigs, or axillary, solitary, consisting of opposite or whorled stamens with a short filament; connective prolonged into an excentric peltate scale-like appendage; anthers 2-6, globose. Female flowers of one-or two-rowed, opposite or whorled scales, which at first are not separable into ovuliferous scale and bract, on a shortened axis. Ovules few to many, sessile at the base of the scale, orthotropous. Fruit a cone with woody or fleshy scales, closely connivent or sometimes bony within. Seeds solitary or geminate, rarely numerous.

Cupressus and *Juniperus* are indigenous in India, while *Callitris* has been introduced into plantations in Madras State.

- | | | |
|--|-----|---------------------|
| Cones fleshy, berry-like | ... | 1. <i>Juniperus</i> |
| Cones dry, of woody scales: | | |
| Cones of peltate woody scales, valvate | ... | 2. <i>Cupressus</i> |
| Cones of one whorl of woody scales, the alternate scales shorter than the two on either side | ... | 3. <i>Callitris</i> |

1. *Juniperus* Linn. This genus comprises trees and shrubs, the latter sometimes prostrate, with leaves of two kinds—those on young plants acicular and spreading, those of older plants scale-like, appressed. The flowers are monoecious or dioecious. The males are ovoid in shape, terminal on short shoots or axillary, solitary or (*J. drupacea*) in groups of 3-6. The stamens are numerous in pairs, or three in a whorl; appendage of the connective scale-like, ovate or peltate; anthers 3-6, hidden under the scale or protruding. Female flowers of a few pointed scales; ovules 1-2 on each scale. Ripe cones berry-like from the coalescence of the fleshy scales. Seeds 1-10, free or, in *Juniperus drupacea*, forming a stony kernel.

Key to the species of *Juniperus*

Trees:

- | | | |
|------------------|-----|----------------------|
| Leaves appressed | ... | <i>J. macrospora</i> |
| Leaves spreading | ... | <i>J. coxii</i> |

Shrubs:

Leaves needle-like in threes:	
Leaf-bases not decurrent	... <i>J. communis</i>
Leaf-bases decurrent	... <i>J. squamata</i>
Leaves scale-like or subulate and pungent:	
Leaves lanceolate, in threes, pungent	<i>J. recurva</i>
Leaves scale-like, decussate	... <i>J. pseudo-sabina</i>

Alternative Key

Leaves all needle-shaped, in threes:	
Leaf-bases not decurrent	... <i>J. communis</i>
Leaf-bases decurrent:	
Under-surface of the leaf furrowed from base up to halfway; no green midrib above	<i>J. recurva</i>
Under-surface of the leaf furrowed from base to apex; a green midrib above	... <i>J. squamata</i>
Leaves on old plants scale-like or only needle-like on young twigs:	
Twigs 4-angled	... <i>J. pseudo-sabina</i>
Twigs rounded	... <i>J. macro-poda</i>

J. macro-poda Boiss. This small or medium-sized tree forms forests of considerable extent at the head of the Kagan Valley, Baluchistan, and in Lahul. At the present time trees over 6-7 ft. in girth are rare but specimens have been measured in Lahul over 33 ft. in girth which must mean an age of well over a thousand years. It is the host of the parasite *Arceuthobium oxycedri* M. Bieb.¹ and many trees are dying in Lahul from this cause. This tree resembles *Cupressus torulosa* in foliage but the branches are shorter and more spreading and, of course, the fruits are quite different. The wood is hard and fragrant and is used locally for fuel. By some it is considered identical with *Juniperus excelsa* M. Bieb.

J. coxii A. B. Jackson. This juniper grows in north Burma and may be the same as a tree juniper found on the Assam-Burmese frontier, hitherto called *J. recurva* Buch.-Ham.

J. communis Linn. (The *J. communis* L. var. *montana* Ait. is the same as *J. nana* Willd. and *J. sibirica* Bongsdorf). This species is prostrate, forming mats on the surface of the soil and not more than 3 ft. high. It is found in rather dry climates, 9,000-14,000 ft., in the north-west Himalayas.

J. squamata Buch.-Ham. This species, which was formerly considered a variety of *J. communis* Linn. is found in the western Himalayas and in the east on the Chinese border.

J. recurva Buch.-Ham. This species is a procumbent shrub, found in the Himalayas between 8,000 and 14,000 ft. Usually

¹ *Loranthaceae*.

associated with *J. communis* Linn. above the tree line on inhospitable soil.

J. pseudo-sabina Fisch. et Mey. This species is found in the inner Himalayas where it grows in dense patches above the tree limit.

A number of European species have been introduced into India.

2. *Cupressus* Linn. Evergreen trees, very rarely shrubs, with scale-like leaves. Flowers monoecious on different twigs. Male flowers small, cylindrical or oblong, terminal on the ultimate divisions of the branches, consisting of numerous stamens, each bearing 2-6 globose anthers; connective produced into an ovoid or peltate scale. Female flowers with several peltate scales, each with ovules in several rows at the base. The cones are more or less spherical in shape, of 6-12 peltate scales, fitting closely together at the margins, ripening in the second year. Seeds 1-many to each scale, leathery, narrowly winged.

The following is a key to the species.

Twigs more or less in one plane:

Twigs roundish, leaves truncate with appressed tips

C. torulosa

Twigs more or less flattened:

Leaves on the twigs appressed or only the tips, somewhat free, bright or grey-green ...

C. funebris

Leaves on the twigs not appressed; plant blue-green

C. cashmeriana

Twigs not in one plane

... *C. sempervirens*

C. torulosa D. Don., a large tree with bark peeling off in long strips, is found in the Himalayas from Chamba to Nepal, 6,000-9,000 ft. This tree is remarkable for the wide variations in climate which it will endure. Parker notes that it grows well in the Punjab, in the plains of northern India. The tree is found commonly on limestone though it by no means avoids soils which have an origin other than limestone. The timber is excellent and is very durable.

C. funebris Findl. A medium-sized tree with wide-spreading curved and pendulous branches. It is commonly planted in the hill-states and plains of India, often in graveyards and cemeteries.

C. cashmeriana Royle (*C. funebris* var. *glauca* Masters). A small tree which apparently is unknown in the wild state though Carrière says it comes from Tibet. Widely cultivated in India where it is a remarkably rapid grower.

C. sempervirens Linn., the Mediterranean Cypress, is commonly cultivated in India. The ascending branches give it a compact cylindrical habit.

3. *Callitris* Ventenat. Evergreen trees and bushes, native of

Australia and Tasmania. Leaves in whorls of three, those of the older plants closely clasping the shoots, except for the triangular scale-like tip, which is sometimes slightly thickened and incurved; those of the younger plants narrow, pointed. Flowers monoecious. Male flowers solitary or in twos or threes at the ends of the branchlets, cylindrical, oblong or ovoid in shape; stamens imbricate in whorls of three or four, carrying 2-4 anther-loculi; connective produced into an ovate-orbicular or slightly peltate scale. Female flowers solitary or in clusters consisting of 6-8 scales placed in two whorls, with several orthotropous ovules, arranged in three or more vertical rows on the upper surface of each scale at the base; supporting bracts are quite absent. Cones globular, ovoid or pyramidal; the valves are united at the base in the same plane into a single whorl, the alternate ones being smaller. Seeds oblong, 2-9 on each scale, with 2-3 broad wings.

C. rhomboidea R. Br. is a moderate-sized tree with feathery foliage, which was introduced into the Nilgiris by Gamble in 1885. It gives an excellent firewood and is grown mainly for that purpose.

VII. GNETALES

This order contains one family.

GNETACEAE

Erect or climbing shrubs without resin-ducts. Leaves opposite or whorled (*Gnetum*) or reduced to a short sheath, 2-4-toothed at the top. Stipules absent. Flowers dioecious, rarely monoecious, arranged in cone-like structures or in axillary or terminal spikes. Male flowers with a 2-lobed perianth, valvate or spathaceous; filaments connate into a column; anthers 2-8, globose, 1-3-locular, sessile or subsessile on the column, dehiscing by short apical slits. Female flowers consisting of one ovule covered with a single integument which is prolonged into a tube having the function of a style, the whole enclosed in a single or double perianth. Fruit baccate, consisting of the succulent bracts enclosing 1-2 seeds (*Ephedra*) or a cone-like structure (*Gnetum*).

A small family of which the genera *Gnetum* Linn. and *Ephedra* Linn. are found in India. *Gnetum* possesses well-developed green leaves. *Ephedra* has very reduced leaves, their function being largely taken over by the green stems of the plant.

Gnetum Linn. One species, *G. gnemon* Linn. is a small ever-green tree found in Burma, and Cachar in Assam. It is quite easily recognized from its twigs swollen at the nodes, the opposite leaves, the cone-like flowers with the sexes on different plants, and the female flower consisting of a naked ovule. The other species of the genus are climbers often reaching a considerable girth.

The other genus *Ephedra* consists in the main of switchy green shrubs but there is one climber, *E. foliata* Boiss., which is common in the more arid parts of the Punjab. This species scrambles over other vegetation and the stems can reach 3 in. in diameter. Parker described the plant thus: 'it climbs over small trees and covers them with a dense mass of branchlets, similar to *Cuscuta reflexa* (*Convolvulaceae*) at a little distance but of a different colour. The plant is also not unlike *Calligonum polygonoides* (*Polygonaceae*) and *Periploca hydaspidis* (*Asclepiadaceae*)'. It is a climber that is unlikely to be mistaken for any other plant if the flowers are examined.

The following is a key to the shrubby species.

Tubillus twisted:

Seeds 2-3 mm. long; bracts of female inflorescence connate in the lower third ... *E. pachyclada*

Seeds 5-6 mm. long; bracts of female inflorescence connate in the lower two-thirds ... *E. intermedia*

Tubillus straight:

Tubillus not more than 1 mm. long:

Strobilus 10 mm. long; seeds 6.5-7.5 mm. long; tubillus 0.5 mm. long ... *E. saxatilis*

Strobilus 5-8 mm. long; seeds 4-6 mm. long, tubillus 1 mm. long ... *E. gerardiana*

Tubillus longer, 1.5-3.5 mm. long:

Branches very smooth; strobilus 5-7 mm. long; seeds 4-7 mm. long ... *E. nebrodensis*

Branches smooth or scaberulous; strobilus 7-10 mm. long; seeds 3.5-4.5 mm. long ... *E. regeliana*

The following is the distribution of the various species:

<i>E. pachyclada</i> Boiss.:	Baluchistan, Chitral
<i>E. intermedia</i> Schrenk et C. A. Mey. var. <i>tibetica</i> Stapf:	Lahul, Spiti, Kashmir, north-west Punjab
<i>E. saxatilis</i> Royle:	Simla, Jaunsar, Garhwal, Kunawar, Kumaon
var. <i>sikkimensis</i> (Stapf) Florin:	Sikkim
<i>E. gerardiana</i> Wall.:	Hills of north and north-west India
<i>E. nebrodensis</i> Tin. var. <i>procera</i> Stapf:	Baluchistan, Kashmir, Chamba, Lahul
<i>E. regeliana</i> Florin:	Ladakh.

Ephedrine, a drug known to the Chinese for the past 5,000 years, is the principal alkaloidal constituent of the plant *Ephedra sinica* Stapf, and is of great importance in the treatment of

asthma and hay-fever. Associated with it in the plant is its isomere pseudo-ephedrine. The bulk of the world's supply of this drug formerly came from China, but the Japanese war and internal unrest interfered with the production of the drug, so that it became imperative to look for alternative sources of supply.

The chemists of the Forest Research Institute turned their attention to the members of the genus common in India with interesting results. It now appears that *E. gerardiana* and *E. nebrodensis* contain ephedrine in quantities equal to or even superior to those found in *E. sinica*. Another species, *E. intermedia*, also contains ephedrine but the main alkaloidal content is pseudo-ephedrine, which, however, is also valued as a drug.

The distribution list above shows plainly that *Ephedra* is a plant of inhospitable arid regions. The plant appears to be able to stand long periods of drought and extremes of heat and cold. There seems to be some correlation between the annual rainfall and the amount of alkaloids present. A high ephedrine content is associated with a low rainfall and vice versa. The content of the drug is also said to be highest in the autumn.

In certain areas in the Himalayas *Ephedra* spp. constitute the only vegetation over large areas and the plants must be of considerable value in stabilizing the soil on steep hill-slopes. The practice, therefore, of pulling up this plant entire when harvesting, instead of leaving the root in the soil, is very much to be deprecated. Such practices only lead to erosion and eventually to the deterioration of the soil to an extent that it will not support any vegetation.

PHYLUM II

ANGIOSPERMAE

As has already been stated, the Angiosperms are distinguished from the Gymnosperms by the ovules being borne in a closed organ, the ovary. Phylogenetically considered, this living group of plants is far more recent than the Gymnosperms and is of great importance to the forest officer because by far the largest part of the forests of India are composed of members of it.

THE PROGRESS OF CLASSIFICATION

It is probable that ever since Man acquired the power of speech, he has given names to each and every object, be it animal, vegetable or mineral, with which he came in contact and for which he had any special use. It will be found that, even among the most primitive peoples, there is a word for every plant that is good to eat, or is unpalatable, or is poisonous. Similarly names exist for animals, fish, birds and so on which are of use as food or for some other purpose. Roughly speaking therefore, classification is as old as the power of speech, but many thousands of years elapsed before any attempt was made to put on record the accumulated experience of those thousands of years. In fact, the first attempt seems to have been that of Theophrastus, 372-287 B.C. Theophrastus was a Greek, and, incidentally, was the successor of Aristotle at the Peripatetic School. He wrote much on botany and among other works wrote a *History of Plants* in nine books, and the *Causes of Plants* in six books, two works which constitute the most important contribution to botanical science from antiquity to the middle ages. It is a fact that his botanical descriptions are much superior to anything which appeared for the next 1500 years.

Padanios Dioscorides, another Greek, who lived circa 50 B.C., was a doctor, and his writings were confined to descriptions of medicinal plants. He detailed the properties of about six-hundred medicinal plants and described animal products of dietetic and medicinal value. His *Materia Medica* was in use and had a great reputation up to the middle ages.

Pliny the Elder (A.D. 32-75) described about a thousand plants, many of them of repute for their medicinal virtues. Other Asiatic writers, mostly Arabians, wrote about plants in the succeeding years, but the striking fact is that no progress what-

ever was made until the sixteenth century. Between the years 1530 and 1536 Otto Brunfels published his *Herbal*, which consisted of the descriptions of a large number of plants, many illustrated by wood-cuts. This was soon followed by Leonardus Fuchs' *Historia Stirpium* (1542) and Hieronymus Bock's *Kreuter Buch* (1539). William Turner, whose herbal printed in English appeared in 1557, is often called the 'Father of English Botany'. John Gerard's *Herball* appeared in 1597. The plants he described were arranged in three books 'sorted as near as might be in kindred and neighbourhood'. The result of this effort was a rough classification, based on superficial resemblances and upon the relationship of the plant with Man. This latter basis was responsible for some very strange grouping. For example, the corn-plant, because of its very special position as a food-plant for Man, was separated on that account from the grasses. On the other hand all sorts of other plants such as *Cyperaceae*, *Juncaceae*, *Stellaria* spp. found themselves grouped with the *Gramineae*.

All of these works, in which the botanical descriptions were subordinated to the medicinal details of the plants, were overloaded with the wildest speculations regarding their supposed medicinal virtues, and often contained much that would be dismissed today as pure fantasy. Gradually, however, a crude system of classification came into being, based partly upon a rough morphology and partly upon the medicinal characteristics of the plants.

The Italian Caesalpini (1519-1603), after whom the genus *Caesalpinia* is named, made a rough classification of plants, based on the characters of the seed and the embryo. He was considered, by Linnaeus, to be the first true systematist.

Kaspar Bauhin (the genus *Bauhinia* was named after him and his twin brother) wrote botanical books at the beginning of the seventeenth century. In his work many natural groups of genera were recognized. The plants were given names and the first signs of a binomial system can be seen in these works, although it was only occasional and sometimes plants were given names which ran into sentences.

The next landmark in the history of plant classification was the appearance between the years 1686 and 1704 of John Ray's *Historia Plantarum*. Ray was the first to examine the seed and discover that seed-plants could be broadly divided into two groups: those with two cotyledons and those with only one.

His scheme was as follows:

Herbae (Herbs)

A. Imperfectae (flowerless)

B. Perfectae (flowering)

1. Dicotyledones

2. Monocotyledones

Arbores (Trees)

A. Dicotyledones

B. Monocotyledones

His biographer has thus summarized his work:¹ 'In general his own work stands out as scientifically on an altogether different level from that of his sources. When he has himself seen and identified a species it is usually easy to recognize; when he has described it, it is almost always fixed beyond doubt. His descriptions are masterpieces of brevity and completeness. He first gives the chief characteristics of the plant as compared with its neighbours; then describes root, stalk, leaves, flowers and seeds; then records its time of flowering, its habits, annual or perennial, and its localities, both general—meadows, hills, marshes, etc.—and particular—often in minute detail; finally he adds notes of quality and medicinal uses. The complete accounts are so good as to make it regrettable that they are almost confined to species otherwise nondescript.'

It was obvious to everybody about this time that some means had to be devised to enable the rapidly growing collections of plants to be dealt with in a reasonable time. Not only had plants to be described, ticketed and docketed but some definite system or scheme was absolutely necessary to ensure that a plant once named could be discovered again. Linnaeus, the great Swede, was the first to supply the answer.

He published his *Systema Naturae* in 1735. In 1737 the *Genera Plantarum* was published, a work in which all genera known to previous writers and to Linnaeus himself were listed. It contained twenty-four classes of plants starting with *Monandria* (one stamen) up to *Icosandria* (more than twelve stamens attached to the calyx) and adding *Polyandria* (stamens attached to the receptacle), *Didynamia*, *Tetradynamia*, *Monadelphia*, *Polyadelphia*, *Syngenesia*, *Gynandria* (stamens adnate to the pistil), *Monoecia*, *Dioecia*, *Cryptogamia*. Linnaeus' classification was thus based solely on the *androecium* and *gynaecium* and their position in relation to each other. Hence the system is always quoted as the classic example of an artificial system, in that it depends on the consideration of one set of characters alone, instead of the whole. There is, however, much evidence which goes to show that Linnaeus himself considered his system to be only one of convenience. In his *Philosophia Botanica* (1751) he listed sixty-seven groups in many of which he clearly saw the natural affinities of certain genera with one another. According to modern ideas many mistakes and blunders are to be found in these fragmenta, but considering the state of scientific knowledge at the time, this grouping cannot be considered as anything other than a great achievement.

¹ C. E. Raven, *John Ray—Naturalist*, Cambridge University Press, 1942, p. 225.

One of the most important contributions which Linnaeus made to botanical science was the system by which he gave to each species a generic as well as a specific name. This binomial system of nomenclature is still followed at the present day. His *Species Plantarum* (1753) is still the book to which all reference is made on nomenclatural problems and no name, whether it be a binomial or not, previous to this date is recognized. Linnaeus, it may be admitted, was not the only botanist to give plants a generic and a specific name, but he was the first exclusively to use a binomial system of nomenclature. Linnaeus' system was warmly welcomed in England and Germany, less so in France.

Botanists could now settle down to reduce the mountainous collections of plants to some kind of order, but there were some who did not believe that Linnaeus' system was the last word in classification. Adanson in France directed attention to the ideal which all should strive for—that all plants should be arranged and classified according to their affinities. He emphasized that to achieve the goal it was necessary that all characters of a plant should be considered and not only the more obvious sexual parts.

Bernard de Jussieu (1699-1777) proceeded to put these considerations into practice. He himself never published a system of classification but his views were incorporated in the work of his nephew, Antoine-Laurent de Jussieu, in 1789. In the latter's system the primary division of John Ray into Dicotyledons and Monocotyledons was adopted, and then advantage was taken of the position of the stamens in relation to the ovary, poly-petaly and gamopetaly of the corolla in order to make further subdivisions. His system was as follows:

Monocotyledons		{ epigynous perigynous hypogynous	
Dicotyledons	{ Apetalae	{	epigynous
			perigynous
			hypogynous
	{ Monopetalae	{	corolla epigynous
			„ perigynous {antheris connatis
			„ hypogynous {antheris distinctis
	{ Polypetalae	{	stamens epigynous
„ perigynous			
„ hypogynous			
	{ Diclines irregulares		

In this system the Cryptogams, since at the time little was known of them, were included in the Monocotyledons. This arrangement was obviously an advance but again it led to the grouping together of families and genera which were in no way related to one another. Actually under this system the *Coniferae* fall into the Dicotyledons. Antoine-Laurent de Jussieu also published a monograph on the *Ranunculaceae* in which he demonstrated the value of considering the whole of the characters and not a selected few. The work of de Jussieu was outstanding in that he was the first botanist to group genera into families which are more or less as we know them today.

Lamarck (1744-1829) found much of value in de Jussieu's work and, in the earlier and mainly botanical part of his career, the series of affinities presented by a systematic study of the vegetable kingdom as a whole made a deep impression on his mind and may possibly have influenced him in the formulation of his evolutionary theories.¹

The good work was carried on by Augustin Pyramus de Candolle (1778-1841). He published his *Théorie élémentaire de la Botanique* in 1813. He recognized the importance of morphology and realized how various parts of the plant became adapted to various physiological ends. He endeavoured to probe deeper than any of his predecessors in order to find the original symmetry which had become obscured by adaptation brought about by abortion, degeneration or cohesion. As a practical example one need only take the number of stamens in *Labiatae*, *Scrophulariaceae* and the genus *Mangifera* of the *Anacardiaceae*.

Next in order comes the system of John Lindley (1799-1865). It was based on that of de Candolle but contained several improvements, among them the distinction between Gymnosperms and Angiosperms. This latter was consequent upon the discovery in 1827 by Robert Brown that the female flower of Conifers and Cycads was really a naked ovule.

Such was the position about the year 1859. Up to this date, which everyone will recognize as the date of publication of Darwin's *Theory of Natural Selection*, all critical minds were clouded with the theological dogma of the immutability of species. The rapid acceptance of the theory of evolution, as formulated by Darwin, by the majority of working biologists gave a great stimulus to those who were working on the classification of plants. From this period onwards the emphasis in plant classification was on phylogeny from the evolutionary standpoint and not merely classification for merely utilitarian purposes. Systems of classification were designated as natural, as opposed to the older artificial systems. In this connexion it may be emphasized that the utilitarian system is not one that

¹ See W. B. Turrill, *Botanical Review* 1942, pp. 260 et seq.

should be despised. After all, the main purpose of a systematist is to identify his plants. If the system he follows with this object in view coincides with the phylogenetic system, well and good, but if not, then the phylogenetic system will be for the seekers after pure knowledge, while the practical system will be that which has most to recommend it to systematists. The systematist's work will not be made any easier by complex theory but by a commonsense logical interpretation and application of morphological facts.

Darwin believed that 'the Natural System is founded on descent with modification; that the characters which naturalists consider as showing true affinity between any two or more species, are those which have been inherited from a common parent, all true classifications being genealogical; that community of descent is the common bond which naturalists have been unconsciously seeking and not some unknown plan of creation, or the enunciation of unknown propositions and the mere putting together and separating objects more or less alike.' Further he said: 'I believe that the arrangement of the groups within each class in due subordination and relation to each other, must be strictly genealogical in order to be natural; but that the amount of difference in the several branches or groups, though allied in the same degree in blood to their common progenitor, may differ greatly, being due to the different degrees of modification which they have undergone, and this is expressed by the forms being ranked under different genera, families, sections or orders.'

The first great event after 1859 was the publication of the system of classification of Bentham and Hooker. This was not an avowed phylogenetic system because it was based very largely upon de Candolle's system in so far as the families and their sequence were concerned. In any event, the work was planned and started before Darwin's views were presented to the public. This great work, *Genera Plantarum* (1862-83), was adopted in England as the basis of classification; and the English herbaria and those in the dominions and colonies have been arranged in accordance with the sequence of families as laid down in that work. As already said, the classification is based on that of de Candolle but greater stress is laid upon the contrast between free and united petals. The Dicotyledons were arranged under *Polypetalae*, *Gamopetalae* and *Monochlamydeae*. *Polypetalae* includes *Thalamiflorae*, *Calyciflorae* and *Disciflorae*. The position of the ovary in regard to the perianth was made use of as a basis for subdivision. The Monocotyledons came last and were arranged in seven series, the first of which was the very complicated *Orchidaceae* passing on to the *Glumaceae*, or grasses and sedges. This vast work, the product of the judgment and experience of two of the greatest systematists who

ever lived, was one of the outstanding events of the nineteenth century.

The *Genera Plantarum* had hardly appeared when the publication of *Die natürlichen Pflanzenfamilien* by Engler and Prantl began in 1887 and was completed in 1909. This work, which was superbly produced and contained many illustrations, was the result of the labours of a large number of botanists. In this system the Monocotyledons take precedence over the Dicotyledons, the *Polypetalae* and *Monochlamydeae* are united and form the single group *Archichlamydeae*. In this group the so-called *Amentiferae*, e.g. such families as *Salicaceae*, *Fagaceae*, *Betulaceae*, *Casuarinaceae*, etc. came to be regarded as primitive and to precede *Magnoliaceae* and *Ranunculaceae*. As will be seen later on there is good evidence to show why the reverse opinion, i.e. that these catkin-bearing families are more recent, should be accepted.

Bessey, in 1897, published his *Phylogeny and Taxonomy of the Angiosperms*. He argued that so far from apetalous being an indication of primitiveness, it was actually the other way about and that his conclusions were that polypetalous preceded apetalous and apocarpous preceded syncarpous. He believed that the angiospermous phylum separated very early into two sub-classes, the Monocotyledons and Dicotyledons. The primitive Dicotyledons were apocarpous plants which developed along diverging lines, characterized in the one case by the tendency of the leaves of the strobilus to fuse with each other in a transverse direction leading from *Ranales* through *Caryophyllales*, *Polemoniales* etc. to *Personales* and *Lamiales*, and on the other hand by the tendency of the leaves of the strobilus to fuse with each other in a transverse as well as a longitudinal direction, leading from *Rosales* through *Celastrales*, *Umbellales*, *Rubiales* to *Asterales*.

Hallier published his *Provisional Scheme of the Natural (Phylogenetic) Systems of Flowering Plants* in 1905. The general features of his scheme are as follows. He considered the Angiosperms to be a natural monophyletic group and not polyphyletic as had been suggested by Engler and Prantl. The *Amentiferae* he considered to be a very advanced group which had been developed by reduction from the *Polycarpicae* (roughly *Magnoliales*, *Annonales*), the latter group being derived immediately from *Bennettitaceae* or other extinct *Cycadales*. He further believed that the *Liliiflorae* and all other syncarpous Monocotyledons have been derived by union of the carpels, by reduction in the number of parts, by epigynous insertion of the perianth etc. from the polycarpous Monocotyledons, which latter group he believed to have been derived immediately from the *Magnoliales*, *Annonales* and *Ranales*.

In 1908 Wettstein published a system of classification which

covered the whole of the vegetable kingdom and is considered to be one of the best books on systematic botany ever written. He, however, followed Engler in believing that those families of the Angiosperms with catkin-like inflorescence are the most primitive of the flowering plants.

Rendle's *The Classification of Flowering Plants*, the first volume of which appeared in 1904, followed twenty years later by the second volume, contains an excellent summary of preceding systems. He followed Engler in his views and starts his treatment of the Dicotyledons with *Salicales* followed by *Juglandales* and *Fagales*.

In 1926 appeared the first volume of *The Families of Flowering Plants, Dicotyledons* by J. Hutchinson. This was followed in 1934 by a second volume on the *Monocotyledons*.

The work was in the words of Dr Hutchinson: 'A phylogenetic system based on the assumption that plants with sepals and petals, associated with other floral and anatomical characters regarded as also primitive, are more ancient phylogenetically than plants without sepals or petals.'

This seems a logical interpretation of the theory that the parts of an angiospermous flower are modified leaves. Free parts are regarded as primitive, and connate or adnate parts as more recent. The spiral arrangement of parts is more primitive than the cyclic (whorl), and numerous free stamens are earlier than the few or connate. Also the hermaphrodite precedes the unisexual flower.

In this system the groups (orders and cohorts) are smaller and families are associated which show close general relationship.

Resemblances are emphasized rather than differences. The *Monochlamydeae* of Bentham and Hooker are distributed among the *Polypetalae* as reduced forms and are regarded as being more recent.

The Monocotyledons are placed after the Dicotyledons, from which they were derived at an early stage, the point of origin being the *Ranales* and perhaps other groups. Recent work on the fossil records strongly supports these theories.'

The principles which were adopted for the classification are set out at length in Hutchinson and are very similar to those laid down by Bessey in *Annals of the Missouri Botanical Garden*, vol. 2, p. 112. According to these principles a flower showing entirely primitive characters would be hypogynous, actinomorphic, polimerous with spirally imbricate parts, hermaphrodite, with a gynaecium of many apocarpous spirally arranged ovaries and an androecium of many stamens with free filaments. The seeds would contain a small embryo and copious endosperm. All modifications of this arrangement such as gamopetaly, peri- or epigyny, syncarpy, few or connate stamens, zygomorphy, the monoecious or dioecious state, apetaly, etc., which indicate

complexity or reduction are considered to be more recent. If the theory of the foliar origin of the carpel and the various parts of the flower is accepted, it is logical to assume that flowers which have the simplest structure, without any complexities of cohesion, and known specialization or reduction, are the most primitive. If this be accepted there are only two families—*Magnoliaceae* and *Ranunculaceae*—in which this simplicity of structure is found.

Actually these two families are the keystones of the two orders, *Magnoliales*, mainly woody, and *Ranales*, mainly herbaceous, which Hutchinson considers to be the two groups exhibiting the most primitive characters, and which he uses as the starting points of his phylogenetic tree. Incidentally it may be mentioned that a phylogenetic tree is the only way of representing a 3-dimensional concept on a 2-dimensional medium.

In order to judge whether a character is primitive or otherwise the only course left open is to go backwards in geological time and examine the geological record as laid down in sedimentary rocks, millions of years old.

The Carboniferous was the age of ferns and in it the *Pteridospermae* (*Cycadofilicales*) reached their highest development. The Mesozoic was the era of Cycads. Probably in the Carboniferous the *Bennettitales* and *Cycadales* developed rapidly as two branches of the Pteridosperms and reached their peak in the Jurassic (Mesozoic).

The *Bennettitales* became extinct in the Upper Cretaceous, whilst the descendants of the ancient *Cycadales* are with us to this day. The living Cycads are closely related to the ferns by reason of their motile spermatozoids, a feature common to all ferns.

Among these groups (*Bennettitales* and *Cycadales*) and even more distantly related groups the strobilus or cone was a common and widespread organ. A typical strobilus consisted essentially of an axis upon which the sexual parts were arranged in spiral fashion.¹

The strobilus was naked or protected in various ways and possessed megasporophylls or microsporophylls or both. A typical strobilus of the Lower Carboniferous—*Lepidodendron*—had a cylindrical axis upon which the frond-like sporophylls were attached, the lower being the mega-, the upper the micro-sporophylls. The task of protection was performed by the distal ends of the sporophylls.

¹ For a discussion of spiral phyllotaxy a reference may be made to *Phyllotaxy*, by A. H. Church, and to *On Growth and Form*, by D'A. W. Thompson.—A cylinder is a very ancient form and is naturally assumed. The steady production of growing parts similarly situated, at similar successive intervals of time, inevitably leads to a spiral arrangement on a cylinder.

The *Bennettitales*, a fossilized group which is very well known, existed for many millions of years and was very successful. The group died out completely in the Cretaceous, for some reason which is not known, and left no descendants. The discovery of numerous fossilized remains of the *Bennettitales* and their study revealed a very specialized type of cone, which had a number of very interesting and suggestive features.

In *Bennettitales* the fructifications are borne laterally wedged in between the persistent leaf-bases and the stem. The strobilus consists of an elongate torus with a number of hairy bract-like (or tepal-like) organs at the base. Above these tepals are 18-20 bipinnate fronds, the male sporophylls. On the apical portion of the torus, at a later stage when the microsporophylls have been shed, are found a large number of orthotropous seeds, erect upon long pedicels which arise directly from the torus. These seeds contain dicotyledonous embryos. Between the seeds are found clavate-shaped organs known as the interseminal scales or paraphyses. Distally these scales are all coherent by their apical margins, thus completely covering the seeds, leaving only a small opening for the micropylar tube.

The discovery that, in this group, the flowers have a perianth of some sort, followed next above by a number of spirally arranged male structures and finally topped by a number of ovaries, also spirally arranged, which gave rise to dicotyledonous embryos, while at the same time preserving their gymnospermal character, gave an impetus to phylogenetic theories.

The reason for this is that up to that time no fossil had been found to which phylogenists could point as the ancestor of the Angiosperms. Even today there is no fossil which can be accepted as that ancestor. It was therefore of great interest to find a fossil which had the characters enumerated above, and which had flowers which remotely resembled the parts of an angiospermous flower.

It was quite clear that *Bennettites*¹ was not the long-sought-for ancestor, but Arber and Parkin formulated a theory which postulated a common ancestor for *Bennettites* and the Angiosperms.²

This hypothetical ancestor of the Angiosperms had a perianth of separate parts arranged spirally. Above this at the base of the cone-like axis were the microsporophylls and above them the megasporophylls, all spirally arranged. The macrosporangia might have been attached to the margin of macrosporophylls which are the homologues of the interseminal scales. The microsporophylls might be of a simpler type.

Following the theory of the foliar nature of the carpel it is

¹ *Cycadeoidea* Buck. is the usually accepted name for *Bennettites* Carr

² Arber and Parkin in *Journ. Linn. Soc. Bot.* (1907), pp. 29-80.

easy to see that if the megasporophylls of the hypothetical ancestor became coherent along their margins and the microsporophylls simplified themselves to the extent that the microsporangia became confluent, we would have the hypothetical angiospermous flower with all primitive features.

Such a flower would possess sterile leaf-like members at the base which afford some protection and play some part in the mechanism for producing cross-fertilization by adding to the conspicuousness of the flower. All members would be of large size, numerous or indefinite and, of course, spirally arranged.

The gynaecium would consist of an indefinite number of carpels forming apocarpous ovaries, each containing several ovules with marginal placentation; no style, but with the stigmatic surface confined to the tip of the carpel; ovules orthotropous with two integuments—dehiscence ventral; embryo with two epigeal cotyledons; androecium of an indefinite number of stamens with long anthers, short filaments and connective produced beyond the tip as a short expansion.

Whether that hypothesis is accepted or not it will be agreed that there are very good grounds for believing that apocarpy, polypetaly, separate stamens, acyclic arrangement of parts are primitive characters. It may be added that the prolongation of the tip of the connective is also to be taken as primitive, as it recalls the sterile tip of the male frond in *Bennettites* and also the small cone scale of the Cycads.

Accepting all these as primitive features there is no difficulty in seeing that the *Magnoliaceae* and *Ranunculaceae* are to be taken as families with primitive characters.

Anatomical studies in *Magnoliales* also bear out this statement. A characteristic of the leaf-anatomy is the peculiar nature of the stoma which runs right through the group. In this type of stoma—the rubiaceous type—the guard-cells are accompanied by special subsidiary cells parallel to the pore. Such cells are absent in the great subphylum of the *Ranales* and are not found even in the woody members of the families contained within it.

Dr Hutchinson considers that such a difference in vital organs, such as stomata, is of great phylogenetic importance and indicates an independent origin for the two subphyla, associated as it is with a difference in habit.

The microscopic structure of the wood of the *Magnoliales* confirms the statement of the phylogenists—based on morphological grounds—that the order shows very primitive characters. Wieland, who did more to elucidate the structure and features of the *Bennettitales* than any other palaeobotanist, has shown that scalariform pitting of the vessels tends to predominate in the cauline centrifugal xylem of the Mesozoic *Cycadeoideae*. In the modern *Magnolias*, to take an example, the vessels are found to have scalariform perforations with many bars, bordered at

the ends, to the middle or completely. Other primitive features of the family are: the vessels are very long, have a small diameter, are polygonal in outline with highly inclined perforation plates, scalariform pitting and walls uniformly thin. Added to this is the fact that the xylem of *Trochodendraceae* and *Winteraceae* (*Drimys*, *Zygogynum*, *Trochodendron*, *Tetracentron*) does not possess vessels—a characteristic of the Gymnosperms. It appears, therefore, that the wood-anatomy of the *Magnoliales* still preserves ancient ancestral gymnosperm and cycadeoidean characters.

Further support for this theory comes from pollen studies in the Jurassic of Scotland. Simpson found pollen of Gymnosperms and Angiosperms in these rocks and, among the latter, grains which could be identified as belonging to *Magnoliaceae* and *Nymphaeaceae*.

During the last quarter of a century a method of serum diagnosis, applicable to plants, has been developed, particularly by Mez in Königsberg, and by Gilg and Schürhoff in Berlin.

In its essentials the method consists of injecting a protein from a plant into an animal. After a certain time a quantity of the blood of the animal is drawn off, cleaned, and the serum so obtained is then ready for the test. A protein of another plant, which is to be tested for relationship with the original plant, is added to the serum. The character and abundance of the precipitate is taken to indicate the degree of relationship; a heavy precipitate indicates close relationship and a very light precipitate the reverse. No precipitate indicates very distant or no relationship. The Königsberg school have drawn up a diagram indicating relationships which correspond very closely to those obtained on purely morphological and palaeontological grounds. The method of serum diagnosis still requires many refinements but there is no doubt that it is a very valuable aid in assessing affinities between families and individual plants.

Such then is a brief sketch of the progress of classification of plants from the earliest times to the present day. From the controversy which still rages over this and that system it is quite clear that the last word on the phylogenetic arrangement of plants has not yet been said.

Moreover there is a feeling among biologists that taxonomists must have a wider outlook and that there must be more co-operation between the taxonomists and specialists in cytology, ecology and genetics. What taxonomists have achieved by the morphological method and deduction is largely confirmed by specialists in other biological sciences who attack the same problems from a different angle, but much remains to be done.

The subject of the *New Systematics*¹ is outside the scope of

¹ Clarendon Press, 1939.

this book but the student is recommended to read the book of that name written by a number of well-known botanists and zoologists and edited by J. H. Huxley, who also contributes a thoughtful introduction.

SUBPHYLUM I

DICOTYLEDONES

Embryo with two cotyledons usually buried in endosperm but sometimes completely filling the seed. Herbs, shrubs or trees. Leaves net or reticulately veined. Stem with open vascular bundles and exhibiting secondary thickness. Flowers frequently showing a pentamerous arrangement.

I. LIGNOSAE

1. MAGNOLIALES

Trees or shrubs ; flowers hermaphrodite, actinomorphic ; ovaries apocarpous, spirally arranged ; stamens numerous ; anthers long ; connective produced ; tepals hypogynous ; embryo minute ; endosperm copious.

I. MAGNOLIACEAE

Trees or shrubs. Leaves alternate, coriaceous in texture, simple, entire, penninerved, reticulate; stipules large, sheathing the young buds, deciduous, leaving a conspicuous transverse scar, rarely absent (*Illicium*).¹ Inflorescence of solitary, axillary or terminal hermaphrodite flowers which are usually large and showy. Sepals and petals (tepals) similar in shape and colour, three, six, nine or many, inserted on the torus in several series, free, imbricate, deciduous. Stamens numerous, hypogynous, free; anthers dehiscing laterally, introrsely or extrorsely; connective often crowned with a blunt awn. Carpels numerous, 1-locular, spirally arranged on an elongated torus; ovules two or more, pendulous and anatropous from the ventral suture. Fruit various, often of ripe carpels separated on an elongated axis, less often in aggregates or rarely hard and woody; dehiscence dorsal or circumscissile. Seeds often covered with a coloured (yellow or scarlet) arillus and suspended by an elastic thread which consists of the uncoiled spiral vessels of the funicle. Embryo minute, straight, at the base of a fleshy copious endosperm.

Taxonomically this family is interesting because of its close

¹ This genus is included in the family *Winteraceae* by Hutchinson.

relationship to the *Winteraceae*, a family in which one genus, *Drimys*, possesses conifer-like characters in the structure of its wood, the vessels of which have bordered pits—a very primitive feature. On the other hand, as Rendle points out, the structure of the bast is typically dicotyledonous, having sieve-tubes and companion cells. Nevertheless the *Magnoliaceae* must be considered a primitive family for obvious reasons: to mention a few—tepals free, numerous free stamens, apocarpous ovaries spirally arranged, small embryo and copious endosperm.

This is an important family from the point of view of the forester, for species of the various genera are frequently found in the evergreen climax forests of Bengal, Assam and in other parts of India as well as in Burma. They are for the most part tall, often very tall, trees with fine straight boles. The timber of some of the species is greatly valued for its excellence as a furniture wood. The size of their flowers, which are often sweetly scented, makes several species desirable plants in a garden. The following is a key to the important genera in our Indian forests.¹

Flowers terminal:

Carpels numerous, apocarpous; fruit not capsular; mature carpels woody or coriaceous, dehiscent; tepals usually fewer than eighteen; connective appendaged, usually much shorter than the anther:

Mature carpels free or conerescent, circumscissile, the upper portions falling away independently or in irregular masses and leaving the persistent lower portions with the suspended seeds; stipules adnate to the petiole, leaving a scar on its upper surface ... 1. *Talauma*

Mature carpels free, dehiscing along the dorsal suture: Gynaecium sessile or shortly stipitate, exserted from the androecium:

Ovules 4 or more ... 2. *Manglietia*

Ovules 2 ... 3. *Magnolia*

Gynaecium stipitate, narrowly cylindrical, not exserted from the androecium; peduncle elongated, slender; tepals 9, subequal; ovules 2-5; stipules free from the petiole, the latter therefore unscarred ... 4. *Alcimandra*

Carpels 2-3, conerescent; fruit capsular, woody, dehiscing completely along the dorsal suture of the carpels and partly along their line of junction; tepals 9, subsimilar; ovules several; stipules free from the petiole, the latter therefore unscarred ... 5. *Pachylarnax*

¹ Based on Dandy's key in *Kew Bulletin*, 1927, pp. 250-60.

Flowers axillary:

Gynaecium stipitate; anthers laterally dehiscent

6. *Michelia*

1. *Talauma* Juss. There are several species of this genus in Assam, Bengal and Burma. *T. phellocarpa* King is a tree common in Upper Assam, yielding a good timber which is much sought after as a furniture wood.

2. *Manglietia* Bl. This genus is mainly confined to the evergreen forests of Assam. One species, *M. hookeri* Cub. et Sm., gives a good furniture wood.

3. *Magnolia* Linn. There are several species of this genus found in the evergreen forests of Assam, Bengal and Burma, some of them growing at fairly high altitudes. The timber is not considered to be of any great value for constructional work or for furniture. It is, however, white, light and fairly strong and it may be possible to use it for matches or tea-boxes. One species, *M. grandiflora* Linn., is an American ornamental tree commonly cultivated in gardens. The flowers of most species are very large, and sweetly scented.

4. *Alcimandra* Dandy. The only species of this genus, *A. cathcartii* Dandy (*Michelia cathcartii* Hook. f. et Thoms.), is found in the Darjeeling, Naga and Khasi Hills. The timber is fit for indoor work.

5. *Pachylarnax* Dandy. Only one representative of this genus, *P. pleiocarpa* Dandy, is found in India. It was discovered as recently as 1933, and is at home in the evergreen climax forests of the Lakhimpur district, Assam. This species, which is distinguished from all the others by the woody concrescent ripe carpels, grows into a tall tree. The timber is said to be hard and capable of taking a fine polish.

6. *Michelia* Linn. A genus with at least a dozen representatives in India and Burma. *Michelia champaca* Linn., the well-known *Champa*, which is perhaps the best-known of them all, is largely grown for ornament in tropical countries for the sake of its sweet-smelling flowers and handsome undulate leaves. The heartwood of this species is strong and durable, is capable of taking a high polish and is valued as a furniture wood. *Michelia fuscata* Bl. is often planted for ornament. The scent of the flowers is like that of amyl acetate and has been described as similar to that of pear drops. The production of the scent seems to be linked with weather conditions. Bright sunlight induces the production of scent while dull weather reduces or stops it.

Those species of *Michelia* which have been tried in pure plantations grow very rapidly but are invariably attacked sooner or later by *Urostylis punctigera*, the borings of which ruin the timber. It is now recommended that they be planted in mixture

with the other species. The species of *Michelia* are very sensitive to fire and even large trees will die on being exposed to a low ground fire.

2. ANNONALES

Trees, shrubs or climbers ; flowers hermaphrodite, actinomorphic ; ovaries apocarpous ; stamens numerous ; connective produced ; petals and sepals hypogynous, in threes, valvate ; embryo minute ; edosperm copious.

2. ANNONACEAE

Trees, shrubs or climbers, generally aromatic. Leaves alternate, simple, entire, penninerved ; petiole usually swollen at the base ; stipules absent. Inflorescence of solitary flowers or fascicles of flowers, which often appear on the old wood in the axils of fallen leaves, occasionally monochasial, in which case the woody axis acts as a hook and assists the plant to climb (*Artabotrys*). Flowers hermaphrodite, rarely unisexual. Sepals three, free or shortly united at the base, imbricate or valvate. Petals often in two series of three each, hypogynous, valvate, rarely imbricate. Stamens numerous, hypogynous, spirally arranged ; anthers 2-locular, loculi dorsal or lateral, opening by a longitudinal slit, often concealed by the overlapping enlarged tip of the connective. Carpels numerous, rarely definite or solitary (*Cyathocalyx*), apocarpous ; styles separate ; ovules 1 - many, basal or parietal. Ripe carpels usually stalked, often sessile, distinct or occasionally united into a many-locular fruit.

This is a family which is frequently represented in evergreen forests of Assam, Bengal and Madras State. The timber of the various species is soft and not durable, but that of some of the larger species (*Polyalthia*) may prove to be useful for plywood.

The trimerous flowers and the stalked fruits of the majority of the species are very distinctive and enable the family to be easily recognized in the forest. When neither in fruit nor flower it is by no means an easy matter to relegate them to the family. The genus *Polyalthia* is, however, an exception. Its dark-coloured bark, horizontal branches, broadly elliptic leaves and snow-white wood are very characteristic of the indigenous species. One of the species of *Polyalthia*, *P. longifolia* Benth. et Hook. f., is very commonly used as an ornamental tree for avenues in India. The margins of the lanceolate leaves are undulate. It is indigenous in Ceylon.

The genus *Annona* is distinguished from the others by the fruit which is large and fleshy and is formed of the confluent ripe carpels. Three species are cultivated in India for their fruit: *Annona squamosa* Linn., the Custard Apple, *A. reticulata* Linn., the Bullock's Heart and *A. muricata* Linn., the Sour Sop.

3. EBENALES

Trees or shrubs ; flowers dioecious or hermaphrodite, actinomorphic ; ovary superior, syncarpous ; loculi 1-2-ovuled ; stamens epipetalous, 2-12 times the corolla-lobes ; petals united, imbricate ; anthers opening by pores ; endosperm copious ; embryo minute.

3. EBENACEAE

Trees or shrubs with dense, often very hard wood. Leaves alternate, simple, coriaceous, exstipulate. Inflorescence of male flowers in many-flowered cymes or fascicles ; female flowers most often solitary. Flowers actinomorphic, usually small, dioecious, the male with a rudimentary ovary, the female with rudimentary or no stamens ; pedicels jointed at the top. Calyx 3-6-fid ; lobes subequal, persistent, sometimes accrescent. Corolla gamopetalous, inserted on the receptacle, deciduous, urceolate, 3-6-lobed ; lobes imbricate. Stamens hypogynous or on the bottom of the corolla, double the number of the corolla-lobes, or twelve times as many ; filaments free or united in pairs ; anthers 2-locular, introrse, opening by longitudinal slits or apical pores (*Diospyros*). Ovary superior, 3 - many-locular ; style rarely simple ; stigma simple or bifid ; ovules solitary in each loculus or geminate, pendulous from the top of the inner angle of the loculus. Fruit a berry, globose, often succulent. Seeds often with ruminant endosperm ; embryo half as long as the cartilaginous endosperm ; cotyledons foliaceous.

There are only two genera of *Ebenaceae* in India. *Diospyros* and *Maba*, which differ from each other by the former being 4-5-merous while the latter is 3-merous. The genus *Diospyros* is comparatively easy to recognize in the forest but with the species it is quite a different matter. The tree species have dark and gloomy crowns with black twigs and buds. The boles have a dark or black bark which may be quite smooth or fissured or covered with small flakes. The outer bark is very hard and brittle but the blaze itself may be white, cream or even pink, very often getting darker or blackening on exposure to the air. The sap-wood and bast are white when cut but almost invariably turn black or dark-brown within a few moments.

Diospyros Linn. This large genus is well represented in India by numerous species of trees and shrubs. Several species are valued for their fruits but the chief interest of the forest officer in the family lies in the fact that several of the species are the source of ebony. *D. kaki* Linn. f. is a small deciduous tree occasionally cultivated in the plains of northern India for its fruit, which is called date-plum or persimmon. Another tree which is often cultivated is *D. lotus* Linn. This is also a deciduous tree with dark-brown or black, tessellated bark. The dark-purple fruits are eaten fresh or dried. *D. peregrina* Gurke

(*D. embryopteris* Pers.) is one of the evergreen species and is frequently cultivated in stations in northern India. The ripe fruits, which are globose and covered with a deciduous red tomentum, contain a honey-like substance which is eaten. The unripe fruit is put to many other uses.

Another tree of economic importance is *D. melanoxylon* Roxb. This is a medium-sized to large tree with greyish-black bark, exfoliating in regular rectangular scales. The leaves of this species are much in demand for wrapping *bidis* and very large numbers are collected each year in Government forests and sold. The wood of the species is also good, having an irregular black heartwood streaked with purple or brown. *D. ebenum* Koenig is the Ebony. It is a large evergreen tree with a thick crown and a dark-grey rough bark with fine longitudinal cracks. The heartwood of this species is jet-black and hard, and is the Ebony of commerce. A large trade in this wood is conducted in Ceylon but the tree is not found in sufficient quantities in the Deccan, where this species is at home in India, to be of any consequence. It is said that the best ebony is obtained from trees growing on rocky well-drained soil. The timber of *D. melanoxylon* Roxb. and *D. tomentosa* Roxb., two species often united under one name, is also termed Ebony in the trade. *D. marmorata* R. N. Parker is the Andaman marblewood, and possesses a heartwood which is dark-grey with darker and often black streaks. It is extremely ornamental and very valuable. *D. oocarpa* Thw. is a small tree found in Bombay State and south India, which also possesses a figured heartwood composed of alternate layers of black and brown.

It is not practicable to give a key to all the species of *Diospyros* found in India and Burma, neither is it possible to give any infallible field character by which the numerous species may be known. So far no satisfactory key has been produced for the species of this genus. The flowers are dioecious and much more research and observation in the field is necessary before a workable key can be compiled. *Diospyros montana* Roxb. can, however, be spotted at once by its blaze, which is light-yellow when fresh, but rapidly turns a dirty-green. In *D. kurzii* Hiern., a graceful tree found in the Andamans, the blaze rapidly turns black. A good many species have a dark-brown to jet-black bark which when blazed shows a narrow black outer ring and inside red, pink or white. When in fruit or flower they are of course unmistakable from the persistent, often enlarged 4-merous or 5-merous calyx supporting a globose fruit. *Cyclostemon confertiflorus* is apt to be mistaken in fruit for a *Diospyros*, but the remains of the stigmas on the top of the fruit and the six sepals should be sufficient to distinguish it.

The reason for the coloured heartwood inside the stems of certain species of *Diospyros* has for long been a matter of interest.

H. Wright remarks that 'the occurrence of ebony within the plant cannot be stated in terms of the age of the tree, the dimensions of the stem or the climatic conditions under which the plants have been grown, though a few facts capable of a very general application may be given. The black heartwood occurs usually in the stem, but is often present in young twigs and roots. The discoloration is black in certain species, mottled and streaked, or red and or even grey in other species. The discoloration may occur in the oldest central wood only or may be present in the shape of streaks and irregular strands. In many young stems the only areas where ebony has been produced are directly associated with insect punctures etc.' The occurrence of the discoloured wood is often erratic and it does not by any means follow that the largest stems will contain the most ebony.

The discoloration of the wood is mainly due to chemical and physical changes of the materials stored in the vessels of the wood. The coloured gummy material entirely fills the lumina of the vessels of the heartwood. Wright concluded that the greater part, if not the whole, of the gummy substance filling the lumina of the vessels is derived from the materials accumulated in the parenchymatous system of the secondary wood. According to him these parenchymatous cells are packed with starch grains, tannin and calcium oxalate and it is when these substances finally disintegrate that globules of coloured material are produced.

On the other hand Griffioen¹ found that the lignin had partly disappeared from the cell-walls of the heartwood of *Diospyros* sp. and that a substance which possessed the characteristics of humic acid had been deposited in the cell-lumina. In the wood parenchyma and medullary ray cells, which remain the longest alive, are found substances which are soluble in alkali and which he regards as the result of the first oxidation processes on the way from lignin to humic acid. As the process goes on the substances become less and less soluble in alkali.

The species of *Maba* are small and shrubby and are of no importance to the forest officer.

4. LAURALES

Trees, shrubs or climbers, sometimes parasites; flowers hermaphrodite or dioecious, actinomorphic; ovary 1-locular; ovule one, pendulous or basal; stamens definite, free; anthers opening by valves or slits; embryo minute; endosperm present or absent.

¹ In *Rec. Trav. Bot. Néerland.*, vol. XXXI (1934), pp. 780-809.

4. LAURACEAE 5. HERNANDIACEAE
6. MYRISTICACEAE

4. LAURACEAE

Trees or shrubs, rarely aphyllous twining parasitic herbs (*Cassytha*), aromatic. Leaves alternate, occasionally opposite or subopposite, simple, entire, penninerved, or palminerved, coriaceous, often pellucid-punctate, exstipulate. Inflorescence umbellate, racemose or paniced. Flowers hermaphrodite, polygamous or dioecious, actinomorphic, small, yellowish or greenish. Calyx usually inferior, gamosepalous, 6-lobed; lobes imbricate; tube sometimes enlarging in the fruit, sometimes persistent (*Machilus*). Petals absent. Stamens 3-4-seriate, often the fourth whorl reduced to staminodes or suppressed, inserted at the base of the throat of the calyx; filaments sometimes glandular; anthers continuous with the filament, 2-4-valved; valves superimposed; valves opening from the base upwards by flaps, introrse or the third row extrorse. Ovary superior, free, 1-locular; ovule solitary, pendulous; style simple; stigma small. Fruit baccate or drupaceous. Seed without endosperm; embryo straight.

The genera of *Lauraceae* are typically at home in the evergreen climax forests of India and Burma wherever these exist. For this reason it is to be expected that the area of the Western Ghats would contain species which are not found in Bengal, Assam and Burma, because the two areas are separated by hot and dry tracts in which lauraceous species do not thrive. This actually is so and few species are common to both areas. This family is generally very easy to spot in the forest. The leaves and bark are often aromatic when crushed. If male flowers can be obtained the anther-loculi opening by flaps are quite characteristic. The following is a key to the genera.

Trees or shrubs:

Stamens of the third row when present with extrorse anthers:

Anthers 2-locular:

Perfect stamens at least 9:

Fruit surrounded by the accrescent calyx-tube ... 1. *Cryptocarya*

Fruit not so surrounded:

Fruiting perianth persistent ... 2. *Apollonias*

Fruiting perianth deciduous; pedicel thickened:

Pedicel as broad as long ... 3. *Dehaasia*

Pedicel much longer than broad 4. *Beilschmiedia*

Perfect stamens 3 or 4:

Perianth segments 6; perfect stamens 3

5. *Endiandra*

Perianth segments 4; perfect stamens 4

6. *Syndiclis*

Anthers 4-locular:

Leaves opposite or subopposite, rarely alternate, usually 3- or more-ribbed; fruiting perianth enlarged into a cupule embracing the fruit 7. *Cinnamomum*

Leaves alternate:

Fruiting perianth-tube enlarged; pedicels also enlarged, thick and warty ... 8. *Alseodaphne*

Fruiting perianth-tube and pedicels hardly enlarged:

Fruiting perianth-lobes reflexed 9. *Machilus*

Fruiting perianth-lobes erect, cup-like 10. *Phoebe*

Stamens of all rows with introrse anthers, the lower loculi sometimes lateral:

Flowers dioecious:

Involucral bracts deciduous in flower:

Fertile stamens 9; leaves penninerved

11. *Actinodaphne*

Fertile stamens 6; leaves often 3-ribbed

12. *Neolitsaea*

Involucral bracts persistent ...

13. *Litsaea*

Flowers hermaphrodite:

Anthers 4-locular ...

14. *Dodecadenia*

Anthers 2-locular:

Stamens 6 ...

15. *Purkayasthaea*

Stamens 9-12 ...

16. *Lindera*

Leafless filiform climbing parasites ...

17. *Cassytha*

1. *Cryptocarya* R. Br. as a genus is easily recognized in fruit from the fact that the drupe is enclosed in the accrescent perianth-tube. There are a good many species in India and Burma, those of the Western Ghats being endemic to that area.

Key to the species of western India

Leaves fulvous-tomentose beneath; flowers in axillary fulvous cymes ... *C. anamalayana*

Leaves glabrous beneath except midrib and nerves:

Flowers in spreading terminal or axillary panicles:

Leaves ovate or elliptic, reddish-glaucous beneath; reticulation dotted-areolate ... *C. beddomei*

Leaves elliptic or elliptic-oblong, glaucous; reticulations not dotted-areolate:

Leaf abruptly and obtusely acuminate

C. bourdillonii

Leaf obtuse or emarginate ...

C. lawsonii

Flowers in congested terminal or axillary panicles:

Leaves elliptic or ovate-oblong, obtuse or slightly acute at the apex; drupe 0.5 in. long ... *C. neulgherrensis*

Leaves obovate or almost orbicular, obtuse or emarginate at the apex; drupe 1 in. long ... *C. stocksii*

All these species are small trees found in the evergreen forests of the Western Ghats and in the shola forests. They are of no importance to forestry apart from the fact that they are indicators of evergreen climax forest.

The Andaman species are as follows (after Parkinson).

Leaves rusty-pubescent beneath:

Tree ; leaves 3-9 in. long ... *C. andamanica*

Shrub ; leaves 6-9 in. long ... *C. ferrarsi*

Leaves glabrous beneath:

Fruit globose ... *C. caesia*

Fruit ellipsoid, pointed ... *C. amygdalina*

None of these species is of any importance.

Key to the species of Bengal, Assam and Burma

Adult leaves ferrugineous-tomentose beneath

C. griffithiana

Adult leaves quite glabrous beneath:

Leaves glaucous-brown beneath ... *C. ferrea*

Leaves not glaucous-brown beneath:

Leaves up to 8 in. long by 3.5 in. broad; fruit up to 1 in. long ... *C. amygdalina*

Leaves up to 15 in. long by 8 in. wide; fruit up to 2.5 in. long ... *C. andersoni*

The leaves of *C. amygdalina* are brown but not glaucous-brown beneath.

These trees are of no importance though *C. amygdalina* Nees sometimes reaches a height of 100 ft.

2. *Apollonias* Nees. *A. arnottii* Nees is an evergreen tree only found in the Western Ghats forests of Tinnevely and Travancore. In appearance it resembles *Phoebe lanceolata* Nees which, however, has 4-locular anthers and stouter peduncles and pedicels.

3. *Dehaasia* Bl. There are only a few species of this unimportant genus in the Andamans and Burma. *D. kurzii* King is endemic to the Andamans ; it is a small tree attaining 30 ft. in height. The bark is thin, of a dirty greenish-grey, with a light-brown blaze. The fruit is 1-1.5 in. long, ellipsoid, glossy, bluish-black, seated on the greatly swollen reddish pedicel. The leaves and fruits are very like those of *Anacardiaceae*.

4. *Beilschmiedia* Nees is a genus of evergreen trees, often of enormous size, found in the evergreen forests of India and Burma wherever climatic conditions are suitable for the development of such forests. The fruiting pedicels are somewhat swollen and orange-red in colour. The genus is not found in the Andamans.

Three species are found in Madras State. They can be distinguished by the following key.

Leaf-buds small, pubescent, without coriaceous scales:

Ovary glabrous ... *B. roxburghiana*

Ovary villous ... *B. bourdillonii*

Leaf-buds elongate ... *B. wightii*

The species of eastern India and Burma can be separated as follows:

Leaves generally alternate:

Branches and petioles rusty-pubescent ... *B. macrophylla*

Branches and petioles glabrous ... *B. roxburghiana*

Leaves usually opposite:

Terminal buds covered with large glabrous coriaceous scales:

Fruit elongate-elliptic ... *B. assamica*

Fruit spherical ... *B. globularia*

Terminal buds pubescent:

Leaves 5-7 in. long ... *B. clarkei*

Leaves up to 3 in. long ... *B. sikkimensis*

The *Beilschmiedias* are of no use as timber although the wood is even-grained and hard. The following are the bark characteristics of a few species.

B. roxburghiana Nees. Bark smooth, light-coloured, nearly white, grey or greyish-brown; blaze reddish-brown turning a deeper brown on exposure.

B. brandisii Hook. f. Bark slightly rough, light-grey in colour, pale-brown or reddish-brown inside, turning a darker colour on exposure.

B. assamica Meissn. Bark pale in colour, grey or greyish-brown, nearly smooth or with horizontal wrinkles; blaze soft, reddish-brown or brown, turning deep-brown on exposure.

5. *Endiandra* R. Br. There is only one species of this genus in India, *E. firma* Nees, and this species, a small tree, is found in the Surma Valley, Assam. Nothing is known of its value as timber.

6. *Syndiclis* Hook. f. *S. paradoxa* Hook. f. is a small tree which has been collected only once in Bhutan.

7. *Cinnamomum* Bl. A genus of evergreen trees with numerous species found usually in evergreen forests of India and Burma, with one species in the Andamans. The leaves are very aromatic when broken and are easily recognized by the triplinervation of most species. Students, however, should not forget that other trees with triplinerved leaves are *Strychnos*, *Neolitsaea*, *Lindera*, *Melastoma*, *Rhodomyrtus*, *Myxopyrum*, etc. As with most species of *Lauraceae*, the species of *Cinnamomum* are divided into two distinct groups, one of which favours the Western Ghats and the other eastern India, with very few species common to both habitats. Before individual leaves fall off they turn a yellowish or orange-red colour.

The species of Madras and Bombay States are separated by the following key.

Leaves opposite (rarely alternate):

Flowers in axillary few-flowered panicles ; peduncles and pedicels slender, long:

Flowers glabrous ... *C. gracile*

Flowers pubescent:

Pubescence grey ... *C. riparium*

Pubescence fulvous ... *C. travancoricum*

Flowers in ample axillary and terminal panicles:

Leaves glabrous:

Panicles long, much-branched; peduncles and pedicels long:

Leaves large, up to 18 in. long, 3-ribbed from a little above the base ... *C. iners*

Leaves not over 10 in. long:

Leaves 3-5-ribbed from a little above the base ; side-nerves ending three-fourths of the way up ... *C. zeylanicum*

Leaves 3-5-ribbed from about 0.3 in. above the base ; side-nerves ending half-way up

C. litseaefolium

Panicles not long ; peduncles long but flowers compact or few-flowered:

Flowers fulvous-tomentose ... *C. wightii*

Flowers not fulvous-tomentose *C. macrocarpus*

Leaves hairy:

Leaves glabrous above and yellowish pubescent beneath

C. sulphuratum

Leaves densely fulvous-tomentose

C. perrottetii

Leaves all alternate:

Leaf-buds with small scales ...

C. caudatum

Leaf-buds with large orbicular scales ...

C. camphora

Key to the eastern species

Leaf-buds with small scales:

Leaves usually opposite:

Leaves glabrous:

Flowers in ample terminal or axillary panicles, longer than the leaves:

Leaves less than 10 in. long:

Bark not very aromatic ...

C. obtusifolium

Bark very aromatic ...

C. zeylanicum

Leaves up to 15 in. long ...

C. iners

Flower panicles as long as the leaves, few-flowered:

Panicles as long as the leaves ...

C. tamala

Panicles shorter than the leaves

C. pauciflorum

Leaves hairy

... *C. tavoyanum*

Flowers in ample panicles	...	<i>C. cacharens</i>
Flowers in few-flowered panicles	...	<i>C. caudatum</i>
Leaf-buds enclosed in orbicular silky scales:		
Panicles large, densely tomentose	...	<i>C. cecidodaphne</i>
Panicles few-flowered, glabrous or nearly glabrous:		
Large tree ; panicle nearly glabrous, few-flowered		<i>C. glanduliferum</i>
Small tree ; panicle glabrous	...	<i>C. camphora</i>

C. zeylanicum Blume gives the true Cinnamon bark of commerce. The species grows into a very large evergreen tree whose home is in the evergreen climax forests of the Western Ghats. The tree, however, is often planted in other parts of India and is a favourite ornamental tree. The bark, which is thick and soft, has a layered brown blaze which is very aromatic. The wood does not seem to be much used.

C. cecidodaphne Meissn. is a very large evergreen tree found in Assam. Its bark is dark-brown or grey, furrowed; blaze usually brown with darker streaks. The timber is considered in Assam to be first-class for furniture and boat-building. The specific epithet is as spelt above, and not *cecicodaphne* as in Brandis.

The following is a key to the species.

Petioles stout:

Inflorescence not more than 8 in. long	<i>A. merguensis</i>
Inflorescence very large, up to 18 in. long	<i>A. petiolaris</i>

Petioles slender:

Inflorescence on a peduncle 3 in. long; leaves elliptic,
about 3 in. long ... *A. owdenii*

Inflorescence on a peduncle much less than 3 in. long;
leaves usually obovate, up to 6 in. long

A. semecarpifolia

Leaves tomentose beneath, at least when young:

Leaves broadly elliptic, rusty-tomentose beneath

A. keenani

Leaves obovate, fulvous-tomentose beneath

A. dumicola

A. merguensis C. E. Parkinson is a tall tree with smooth bark and young parts clothed with a reddish-brown pubescence. This tree is confined to Burma where it occurs in several districts. Nothing is known of its uses.

A. petiolaris Hook. f. is a large tree found in Assam and Upper Burma. The bark is greyish-brown or dark-grey with vertical fissures; blaze soft, somewhat greasy, pinkish or light reddish-brown with distinct broad white streaks. The wood is coarse-grained, reddish, and is apparently not used.

A. owdenii R. N. Parker is a tree found in the evergreen forests of the Surma Valley, Assam. It reaches a height of 60 ft. Its bark is grey and somewhat rough outside, covered with several layers of soft dun-brown or cream-coloured cork; blaze first dun-brown, mottled (especially at the outer edge of the blaze) with brown somewhat granular strands, turning reddish-brown on exposure. The timber is of good quality and is much valued in the Surma Valley.

A. semecarpifolia Nees is the representative of this genus on the west coast of the Peninsula, where it is a member of the evergreen climax forests of the Western Ghats. It is often, as at Top Slip, Coimbatore, found in considerable numbers. It is a tall tree with a dark-red or brown bark, fissured somewhat like crocodile-hide. The petioles of the young leaves are bright-red in colour. The tree has two varieties, viz. var. *angustifolia* Meissn. with glaucous elliptic-oblong or lanceolate leaves and var. *parvifolia* Hook. f. with small obovate or oblanceolate leaves. The timber is strong and much esteemed as a building-timber.

A. keenani Gamble is a middle-sized tree found in Assam in several districts. The bark is grey and smooth and the blaze brown with distinct streaks of white tissue. The pedicels of the fruits are much thickened and crimson in colour. The timber is not used.

A. dumicola W. W. Sm. is a small tree found in the Naga Hills. Nothing is known of it.

9. *Machilus* Nees is a genus of evergreen trees which is easily recognized when in fruit from the persistent recurved calyx-lobes.

The species are confined for the most part to the evergreen forests of the eastern side of India. There is one species in Madras State (penetrating to Orissa).

M. macrantha Nees is a very large tree with a cylindrical bole. The bark is light-brown with darker spots upon it; blaze pinkish and greasy to the touch. The wood is known in the trade as Machilus. The other species of *Machilus* are not of much importance. *M. bombycina* King is a small to middle-sized tree, often cultivated in Assam as a host for the *Muga* silkworm. *M. globosa* Das is a tall tree found in the districts of eastern Assam, where the timber is often sold as the commercially more valuable Bonsum.

10. *Phoebe* Nees is a genus of evergreen trees of which a number are important timber-trees.

The following is a key to the Indian and Burmese species.

Lobes of the fruiting perianth appressed, rigid:

Perianth glabrous:

Leaves lanceolate, 5-8 in. long, more than 1 in. broad

P. lanceolata

Leaves linear-lanceolate, 6-10 in. long, less than 1 in. broad

... \ *P. angustifolia*

Perianth silky or pubescent:

Lateral nerves 8-12 pairs:

Young shoots minutely puberulous

P. pallida

Young shoots rusty-tomentose ...

P. paniculata

Lateral nerves 15-20 pairs ...

P. attenuata

Lobes of the fruiting perianth not appressed nor rigid, coriaceous:

Leaves glabrous

... *P. hainesian*

Leaves more or less pubescent:

Perianth puberulous outside, villous inside

P. goalparensis

Perianth grey-tomentose outside, glabrous inside

P. cooperiana

P. lanceolata Nees. This small evergreen tree with a pale yellowish-white bark, often covered with lenticels, is found all over India and in many parts of Burma. The blaze is thick, brown or flesh-coloured. The leaves are extremely aromatic and the bark smells of cinnamon. Unlike its congeners it is found in rather open and dryish forest, as, for example, the bhabar tracts of the Assam sal forests.

P. pallida Nees is a moderate-sized tree found in south-eastern India, ascending in the hills to 6,000 ft.

P. paniculata Nees is a tall tree with a dark-grey bark, reticulately fissured; blaze fibrous at first, cream-coloured, afterwards turning brown. The tree has a characteristic appearance in the forest for the leaves are crowded at the

ends on the branches. This tree is common in the hill-forests of Assam.

P. attenuata Nees. This moderate-sized to large tree is fairly common in the Assam hill-forests and also in those of Bengal, extending into Burma. The bark of this tree is dark-grey, exfoliating in papery flakes; blaze brownish with darker brown specks. The timber is highly valued and is excellent for cabinet-making.

P. hainesiana Brandis, *P. goalparensis* Hutch. and *P. coope-riana* Das are three trees which yield the valuable timber called Bonsum in Assam. The first-named is found in the Naga Hills, always in evergreen climax forest about 4,000-5,000 ft. The other two are plains-dwellers and also grow into magnificent trees.

11. *Actinodaphne* Nees. This genus, like the other genera of *Lauraceae*, is confined to the evergreen climax forests of India. They are easily recognized in the forest because of the arrangement of the leaves. These are collected at the ends of the otherwise bare twigs and are so crowded as to be subverticillate and are set at right angles to the twig. The flowers are dioecious.

12. *Neolitsaea* Merrill was at one time considered to be a section of *Litsaea* but was rightly given generic rank by Merrill as long ago as 1906. The 3-ribbed leaves are reminiscent of species of *Cinnamomum* but the flowers are very different. The species are of no importance.

13. *Litsaea* Lam. This genus contains a very large number of species, the large majority of which are found in evergreen climax forests. The seeds of the species contain lauric acid and are economically valuable. It must be remembered, however, that the trees are dioecious and that numerous individuals of any species do not mean large quantities of fruits. For this reason it is advisable to undertake research into the vegetative propagation of *Litsaea*. The leaves of the species of this genus are aromatic and the species can usually be referred to *Lauraceae* without difficulty, and when flowers and fruits are present, to the genus. It is often quite difficult, however, even when all these adjuncts to identification are present, to run a species down from a description alone. This is so, particularly in regard to the Madras species, many of which are new species erected by Gamble. It is usually necessary to compare them with authentically named specimens in a large herbarium. Several species can, however, be recognized at once by other characters.

L. citrata Bl. is a small deciduous tree found in the Himalayas and Assam plains-districts. The trunk and branches are covered with a bright-green bark which, with the leaves, dries black. The flowers smell deliciously of oranges. The *Pat* silkworms are reared on the leaves of this tree and the well-known Assam silk is spun from the cocoons.

L. chinensis Lam. (*L. sebifera* Pers.) is a deciduous tree found in many parts of India and Burma. The bark is greyish-brown in colour, rough; blaze yellowish mottled-brown, greasy to the touch.

L. monopetala (Rozb.) Pers. (*L. polyantha* Juss.). This middle-sized tree is found generally all over India and in Burma. The bark is greyish-brown, somewhat rough; blaze reddish-brown. The leathery leaves provide food for the *Muga* silk-worm.

14. *Dodecadenia* Nees is a small genus of evergreen trees with three species found in the hills of north-east India. They are not of any importance.

15. *Purkayasthaea* Purk. is a strange genus with a strange name. There is one species, *P. pseudomicropora* Purk. et Naray., a middle-sized evergreen tree found in the climax forests of Upper Assam.

16. *Lindera* Thunb. is a genus containing a number of small deciduous or evergreen species. None of them is of any importance in forestry.

17. *Cassytha* Linn. *C. filiformis* Linn. is a leafless parasite attaching itself by means of haustoria to trees and shrubs. It resembles that other parasite, *Cuscuta reflexa* Linn., but is much greener and it is curious that the two parasites are seldom found in the same area. The pounded stems are used in indigenous medicine.

5. HERNANDIACEAE

Climbing shrubs or large trees. Leaves alternate, simple or digitately compound, exstipulate. Inflorescence of bracteate or ebracteate, panicle or axillary, corymbose cymes. Flowers actinomorphic, hermaphrodite, monoecious or polygamous by abortion. Calyx superior, 4-10-lobed; segments subequal, valvate, in one or two whorls. Stamens 3-5 in one whorl, often four, when the perianth is double opposite the outer lobes; anthers 2-locular, opening introrsely or laterally by two valves; staminodes gland-like, in one or two whorls outside the stamens, those of the outer whorl in pairs at the base of the filaments, those of the inner whorl alternate with the filaments. Ovary inferior, 1-locular; ovule one, pendulous. Fruit with two wings or wingless, with or without two additional smaller wings. Seed without endosperm; embryo straight.

The affinities of this family are not at all clear. The solitary pendulous ovule and the anthers opening by valves were the reason for the genus *Hernandia* having been included in *Lauraceae*; the winged fruits were considered a sufficient reason for placing *Gyrocarpus* and *Illigera* under *Combretaceae*. The inferior ovary, however, and the character of the fruit, as well as the arrangement of the stamens, are quite different.

This interesting family has three genera in India which can be distinguished by the following key.

- | | | |
|---|-----|----------------------|
| Leaves trifoliate | ... | 1. <i>Illigera</i> |
| Leaves simple: | | |
| Leaves peltate; fruit ovoid, not winged | ... | 2. <i>Hernandia</i> |
| Leaves ovate; fruit winged | ... | 3. <i>Gyrocarpus</i> |

1. *Illigera* Bl. There are three species in this genus of which one, *I. appendiculata* Bl., is a large climber found in the Andamans, Burma and Assam. The other two species, *I. khasiana* C. B. Clarke and *I. villosa* C. B. Clarke, are found in the hills of Assam. The fruits are broadly 2-winged.

2. *Hernandia* Linn. *H. peltata* Meissn. is a moderate-sized to large tree growing at the water's edge on the coasts of the Andamans and Malaysia but it is not considered to be a part of the mangrove community. The bark is silvery grey-buff and the blaze is a pale brownish-buff with broad whitish streaks. The peltate leaves and the leaf-scarred branchlets make this tree easy to recognize in the forest. The fruit is very peculiar. It consists of a greenish-white, globular receptacle with a circular opening at the top, inside which is a dark-coloured ribbed drupe. The wood is soft and light-coloured but does not appear to be used. Parkinson says the local name of this tree in the Andamans is Jack-in-the-box plant.

3. *Gyrocarpus* Jacq. This is a monotypic genus, *G. jacquinii* Gaertn. (*G. americanus* Auct. non Jacq.) being the only species. It is found on the shores of both sides of the Peninsula and of Burma. This species is a deciduous tree, often reaching a large size, with large soft, often lobed, leaves. The bark is thin, greyish-white with a silvery lustre. The fruits are quite characteristic, consisting of a drupe, crowned with the long wing-like persistent perianth-lobes. The wood is soft and light and is preferred above all others for the making of catamarans. It is also used for making toys, trays and other small articles.

6. MYRISTICACEAE

Large trees or shrubs, often aromatic, with reddish juice. Leaves alternate, distichous, coriaceous, simple, entire, often with pellucid dots, exstipulate. Inflorescence of fascicles, corymbs, capitate or of axillary compound panicles. Flowers dioecious, inconspicuous, white or yellow, apetalous, actinomorphic. Calyx simple, coriaceous or urceolate, or subcampanulate, 3- (rarely 2-5-) lobed; lobes valvate. Male flowers; stamens 6-30; filaments united into a column; anthers 2-locular, free or united into a mass, opening by longitudinal slits; rudimentary ovary absent. Female flowers; ovary superior, sessile, 1-locular;

ovule one, basal; stigma subsessile; staminodes absent. Fruit capsular, fleshy, often dehiscent by two valves. Seed with a fleshy, often laciniate, coloured aril, with a ruminant endosperm; embryo minute, straight.

This family, which is also known as the Nutmeg family, is widely distributed in the tropics of both hemispheres. Of the species found in India and Burma, there are only a few which have any timber value at all, and the wood in most of the species is peculiarly liable to decay. The species are, however, of frequent occurrence in the underwood of the evergreen forests of India and Burma. The genus as a whole is easily recognized in the forest on account of the characteristic pale-red or blood-red sap which flows from the blazed bark. In this way the family can be separated from members of the *Annonaceae*, which, in the absence of flowers or fruits, are extremely similar in appearance. Species of the *Annonaceae* have no red juice in the blaze. In addition to this the habit of the trees is quite unmistakable. They have cylindrical boles with horizontal branches and pendulous coriaceous leaves. The fruits are globose or ellipsoidal-valvate capsules, enclosing a seed which is surrounded by a fleshy, entire or lacerate, red or yellow aril. Warburg in his *Monographie der Myristicaceen* divided this family, which had, up till then (1897) been monogeneric, into fifteen genera, of which the following are found in India: *Myristica*, *Knema*, *Horsfieldia*, *Gymnacranthera*.

This division has been accepted in most modern works on taxonomy, but wood-technologists doubt the validity of the change and assert that the woods are identical for all practical purposes. *M. fragrans* Linn., the Nutmeg, originally indigenous to the southern Moluccas, is cultivated on a large scale in Malaya and is occasionally cultivated in south India. The home of the tree appears to be in east Malaysia but it was imported into India probably during the Sanskrit period. The tree is known in all the important languages of India, including Burmese, by a word derived from the Sanskrit, and which first appeared in Sanskrit literature circa A.D. 600 (Burkill). The lacerate arils of the seed of this species constitute the spice known as Mace, while the seeds themselves are the Nutmegs of commerce. As the species are dioecious it is a matter of importance when making plantations of this tree to determine the sex of each tree as it flowers so that the excess male trees may be weeded out and replaced by females. The seeds of several other species are rich in fats and oils and yield vegetable tallows and waxes which are used locally to make candles and soap. Indeed, the species *M. canarica* Bedd. is so rich in fats that the seeds can be crushed and pressed down into hollow bamboo joints, after which they can be burned, without the addition of a wick, as an illuminant.

5. DILLENIALES

Trees, shrubs or climbers; flowers hermaphrodite or dioecious, actinomorphic; ovaries apocarpous; stamens 5-10 or numerous; embryo small to large; seeds arillate with copious or scanty endosperm.

7. DILLENIACEAE 8. CONNARACEAE

7. DILLENIACEAE

Trees, shrubs or climbers, rarely undershrubs. Leaves alternate, entire or toothed, usually with numerous prominent spaced parallel lateral nerves; stipules absent or adnate to the petiole and caducous. Flowers yellow or white, often showy, small to medium-sized, sometimes large, hermaphrodite or monoecious. Sepals five in number, persistent, imbricate. Petals five (rarely three or four), imbricate, often crumpled in the bud, deciduous. Stamens numerous, hypogynous, free or variously united into bundles at the base; anthers dehiscing laterally or introrsely by slits, or terminally by apical pores. Carpels one or more, free, sometimes connate at the inner angle. Ovules one or more, anatropous, erect from the base or the inner angle. Fruit dehiscent or baccate; seeds usually with a crested aril (except in *Dillenia*); embryo minute in a copious endosperm.

The genus which the forester is most likely to meet frequently in his forests is *Dillenia*. This genus is interesting because after fertilization the imbricate sepals continue to grow in fleshiness until at last they come to form an almost spherical (oblate spherical) succulent fruit enclosing the ripe carpels.

Dillenia indica, with an orange-red papery scaly bark and very large showy white flowers and a fruit, often 6 cm. in diameter, is widespread in India. The fruit is much sought after by elephants and the seeds are distributed in this way. The fruit is extremely tart but with plenty of sugar can be eaten when stewed. It is sometimes used as a substitute for soap and as a head-wash. It is very common on the banks of streams and indicates moist places. As mentioned, the fruits can be dispersed by elephants but more often they fall into water and are carried away to germinate where they are washed up on a bank. The fallen fruit quickly decays and white ants (termites) eat out the pulp, filling up the fibrous shell of the fruit with earth. The seeds are left untouched and germinate the following year in the seed-bed provided for them by the white ants. *Dillenia pentagyna* is one of the few trees which can stand fires once it has reached maturity and is a common associate in forest which is transitional between burned savannah and the climax. It is a deciduous tree and extremely difficult to eradicate. It is useless to girdle it, and if cut down it sends out numerous coppice shoots of great strength. After the tree is felled the

stump continues to bleed for a very considerable period. One species of *Dillenia*, found in south India, *D. bracteata*, a tall tree, is common in the evergreen forests of the Western Ghats in Madras State. There are several other species of *Dillenia* in Assam and Burma.

Another species of this family, *Delima sarmentosa* Linn., is a common creeper in the evergreen forests of Assam and Burma. Its leaves are very harsh to the touch and are sometimes used to polish ivory and tortoise-shell.

The timber of the various species of the genus *Delima* is quite useless and will decay in the open in a single year.

8. CONNARACEAE

Trees or shrubs, erect or climbing. Leaves alternate, imparipinnate or 1-3-foliate with quite entire leaflets, exstipulate. Flowers usually hermaphrodite and actinomorphic, sometimes slightly zygomorphic, arranged in racemes or panicles. Sepals five, connate below, imbricate or valvate. Petals five, free or sometimes slightly connate, imbricate. Stamens ten, free, or the lower portions connate into a short tube; anthers 2-locular, opening lengthwise. Carpels five, each 1-locular, with two ovules in each loculus, collateral, ascending from the inner angle. Fruiting carpels one only, irregular, 2-valved. Seeds often arillate, with or without endosperm.

A rather large family of species, mainly climbing. They can be recognized in the forest by the one-seeded capsule which is obliquely shaped and the seed with a brightly coloured, yellow or red, arillus.

6. CORIARIALES

Shrubs ; flowers hermaphrodite or dioecious ; actinomorphic ; sepals and petals present, hypogynous ; apocarpous ; ovule solitary in each carpel ; stamens ten ; embryo straight ; endosperm scanty.

9. CORIARIACEAE

Glabrous shrubs with angular branches. Leaves opposite and ternate, simple, entire, exstipulate. Flowers hermaphrodite or polygamous, small, solitary or clustered in the axils or forming dense racemes. Sepals five, ovate, with membranous margins, imbricate, persistent. Petals five, shorter than the sepals, keeled within, after flowering becoming enlarged or thickened and enveloping the fruit. Stamens ten, hypogynous, free, or those opposite the petals adnate to the keel; anthers large, oblong, introrse, opening lengthwise by slits. Ovary of five or ten carpels, which are free, 1-locular. Ovules solitary in each loculus, pendulous from the top. Fruit of five or ten compressed, dry

nuts enclosed in the enlarged petals. Seeds with scanty endosperm.

Coriaria nepalensis Wall. is a glabrous shrub with 4-angled branches and yellow racemose flowers, red stamens and red bark. The local name in the outer Himalayas is *Masuri* and the town of Mussoorie is said to have received its name from it, as the shrub is particularly abundant in the neighbourhood. The fruit is strange, consisting of five achenes surrounded by the five enlarged purple succulent petals. The wood of this species is said to be handsomely marked but it is not used.

7. ROSALES

Trees, shrubs or herbs ; flowers hermaphrodite ; sepals and petals free ; carpels free or variously united and the inferior stamens perigynous to epigynous ; endosperm absent.

IO. ROSACEAE II. CHAILLETIACEAE

IO. ROSACEAE

Trees, shrubs or herbs of various habit. Leaves alternate or rarely opposite, simple or compound, often with glandular teeth, stipulate; stipules persistent or caducous, usually paired, sometimes adnate to the petiole, rarely absent (*Spiraea*). Inflorescence various, definite or indefinite, sometimes of solitary flowers, or of simple racemes (*Agrimonia*), or of dense heads, or of corymbose cymes. Flowers actinomorphic and hermaphrodite, rarely zygomorphic. Calyx free or adnate to the ovary, occasionally with an epicalyx (*Geum*, *Potentilla*), 5-lobed, lobes imbricate, the fifth adaxial. Petals the same number as the calyx-lobes, white, red or yellow, equal, imbricate, often showy, very rarely absent (*Alchemilla*). Stamens bent inwards in the bud, variable in number, 1-numerous; filaments free, rarely connate; anthers 2-locular, opening by longitudinal slits. Ovary of one or more carpels, free or variously connate; ovules in each carpel two or more, superposed. Between the stamens and carpels lies a cushion-shaped or ring-like nectar-secreting disk. Fruit superior or inferior, drupaceous, pomaceous, follicular or achenial, sometimes on an enlarged fleshy torus. Seeds without endosperm.

This very large family is not of much account from the point of view of the practical forest officer, since none of the species produces a timber which is of outstanding merit. Apples, plums, pears, peaches, apricots, loquats, sweet and bitter almonds and the strawberry are all members of the family as well as a large number of garden-plants which are cultivated for their beautiful

flowers. Some of the prostrate *Cotoneasters* are of value above the tree line, where their very close growth and strong root-system enable them to hold up masses of snow, materially helping in the prevention of erosion.

Key to the genera of *Rosaceae*

- Ovary superior; ripe carpels not enclosed in the calyx-tube:
 Flowers irregular; ovules 2, ascending; carpel 1
 1. *Parinari*
- Flowers regular; ovules 2, pendulous:
 Carpel 1:
 Drupe erect; style terminal:
 Petals large; endocarp bony ... 2. *Prunus*
 Petals very small; endocarp coriaceous 3. *Pygeum*
 Drupe inverted: style sub-basal ... 4. *Prinsepia*
- Carpels many:
 Ovules 2; prickly shrubs ... 5. *Rubus*
 Ovule 1; herbaceous ... 6. *Potentilla*
- Ovary inferior; ripe carpels enclosed in the calyx-tube:
 Carpels not confluent when ripe; prickly shrubs with compound leaves and adnate stipules ... 7. *Rosa*
 Carpels confluent when ripe; erect trees or shrubs with simple leaves and small stipules:
 Flowers in panicles; ovary 5-locular 8. *Eriobotrya*
 Flowers solitary, corymbose or fascicled:
 Ovary up to 5-locular; 3 ovules or more in each loculus:
 3 ovules in each loculus ... 9. *Eriolobus*
 (Mocynia)
 Many ovules in each loculus ... 10. *Cydonia*
 Ovary 2-5-locular; 2 ovules in each loculus:
 Endocarp bony:
 Leaves entire ... 11. *Cotoneaster*
 Leaves cut ... 12. *Crataegus*
 Endocarp not bony:
 Fruit a pome; endocarp cartilaginous 13. *Pyrus*
 Fruit drupaceous; endocarp thin 14. *Photinia*

1. *Parinari* Juss. A small genus of evergreen trees, the species of which occur sporadically in the evergreen climax forests of India and Burma (except, surprisingly enough, in those of Assam). There are two species in the Western Ghats forests of Madras State; *P. indica* Bedd. (leaves 8-9 in. long) and *P. travancorica* Bedd. (leaves 4-5 in. long). The bark of the latter is said to be smooth and mottled brown and white.

2. *Prunus* Linn. This genus is confined naturally to the Himalayas and hills of eastern India. Cherries and almonds,

peaches and plums, are cultivated everywhere where the climate is suitable. There is one species in the Andamans.

The following is a key to the commoner species found wild in the Himalayas (after Parker).

Leaves about 1 in. long; small shrubs:

Leaves and twigs glabrous ... *P. jacquemontii*

Leaves and twigs pubescent or velvety ... *P. prostrata*

Leaves over 1 in. long; large shrubs or trees:

Flowers solitary or fascicled:

Pedicels slender, about as long as the calyx-tube

P. cerasoides

Pedicels absent or short and thick:

Leaves much longer than broad ... *P. persica*

Leaves nearly as broad as long ... *P. armeniaca*

Flowers in racemes ... *P. cornuta*

P. jacquemontii Hook. f. This is a small deciduous shrub found at elevations between 9,000 and 12,000 ft.

P. prostrata Labill. is a small prostrate deciduous shrub, found in the inner valleys of the Himalayas; for example, Pangi and Lahul.

P. cerasoides D. Don (*P. puddum* Roxb.). A tree of the Himalayas, Khasi and Naga Hills and Upper Burma, where it flourishes between 2,500 and 8,000 ft. It is often cultivated for the sake of its handsome flowers. The bark is brown, smooth, shining, peeling off in horizontal strips like the common cherry. Troup says that the Burmese tree is evergreen or nearly so, but this is not borne out by herbarium specimens. The tree, as found in the Naga Hills, produces its pink flowers in abundance in March-April before the new leaves appear. According to Troup, quoting Gamble, there are two varieties of the tree in the Darjeeling Hills: (a) a very large tree with crimson flowers which appear in March and (b) a small or medium-sized tree with pink flowers which appear in October-November. It appears that the colour of the flowers is variable, ranging from white to bright-crimson. The fruit, a yellow or red ovoid drupe, is eaten by the hill-tribes. *P. campanulata* Maxim. is a Japanese and Chinese species which is said to occur in Burma. It is extremely close to *P. cerasoides* and has even been considered to be a variety of that species. This species provides a very good stock for the cultivated cherry.

P. persica Stocks. The Peach. This tree is completely naturalized in many parts from the plains to 10,000 ft. A double-flowered variety is also cultivated. It is a magnificent sight in full bloom. The ordinary cultivated species has a rough velvety-brown pointed fruit which ripens very late.

P. armeniaca Linn. The Apricot. This tree is cultivated in many places in the Punjab Himalayas for the sake of its fruit.

P. cornuta Wall. (*P. padus* of the F.B.I.). The Bird Cherry. A moderate-sized or large deciduous tree with brown scaly bark. A very widely distributed species. It is very common in the Punjab Himalayas in deciduous forest between 6,000 and 10,000 ft.

The Andaman species is *Prunus martabanica* Kurz. It is a large deciduous tree with a chocolate-brown bark which peels easily from the sap-wood; blaze dark-red, smelling pleasantly of almond essence. The ovate-oblong leaves are covered on the lower surface with black dots.

Many other species of *Prunus* are cultivated in the hills for their fruit. *P. cerasus* Linn. the Wild Cherry, *P. avium* Linn. the Sweet Cherry, *P. cerasifera* Ehrh. the Plum and *P. amygdalus* Baill. the Almond.

3. *Pygeum* Gaertn. A small genus of evergreen trees found in the Western Ghats, Bengal, Assam and Burma in evergreen climax forest. The coriaceous entire leaves often have a pair of large circular glands on the underside of the blade near the base. The bark of *P. wightianum* Bl. (Western Ghats) and that of *P. acuminatum* Colebr. (Assam, Bengal) smell strongly of bitter almonds.

4. *Prinsepia* Royle. *P. utilis* Royle is a spinescent deciduous shrub with bright-green branches, which is found in the Himalayas, the Khasi Hills and Burma. It is valued as a hedge-plant in many places. The seeds contain an oil which is used as an illuminant.

5. *Rubus* Linn. This genus is a well-known one in India, being found in hills and plains. The majority of the species are sarmentose shrubs, often prickly, with compound or simple leaves and typical red or yellow raspberry-like fruits. *R. idaeus* Linn., the cultivated Raspberry, is found in cultivation in hill-stations.

6. *Potentilla* Linn. contains many species with handsome yellow or red flowers which are found at high elevations in the Himalayas. Some of the species reach the size of a small shrub.

7. *Rosa* Tourn. A genus of erect or climbing shrubs, usually armed with prickles. A well-known genus in gardens, where many varieties are grown for their magnificent flowers.

Several species are found in the forests of India and Burma.

The following is a key to the wild species.

Erect shrubs:

Flowers 5-merous:

Prickles yellow, broad based:

Leaves 2-8 in. long; leaflets 7-11; fruit 1-1.5 in. long

R. macrophylla

Leaves 0.5-2 in. long; leaflets 5-9; fruit 0.5 in. long

R. webbiana

Prickles few, usually a pair infrastipular

Flowers 4-merous	...	<i>R. involucrata</i>
Climbing shrubs:		<i>R. sericea</i>
Evergreen	...	<i>R. longicuspis</i>
Deciduous	...	<i>R. moschata</i>

Of these species, *R. involucrata* Roxb. and *R. longicuspis* Bertol. are found in Assam and the remainder in the Himalayas.

8. *Eriobotrya* Lindl. The best-known species of this small genus of trees is the Loquat, *E. japonica* Lindl. It is said to be indigenous in China and Japan but it is widely cultivated in northern India. It is easily recognized by its terminal panicles of fragrant white flowers and very tomentose shoots and leaves. There are, however, several other species wild in India, and some of them, for example, *E. bengalensis* Hook. f., are worth cultivating for their showy white panicles of flowers. This tree is fairly common in the evergreen forests of Bengal and Assam.

9. *Eriolobus* M. Roem. *E. indica* Schn. (*Docynia indica* Dcne.) is a small to middle-sized tree common in the hills of eastern India, 4,000-6,000 ft. The leaves of young plants are much divided and almost glabrous, resembling those of hawthorn. The leaves of big trees as well as the stipules, young shoots and calyx are covered with a dense white tomentum. The fruit is yellow, ovoid, 1.5-2 in. long, crowned by the persistent calyx-limb, edible. This is the Quince of residents in Kohima in the Naga Hills. The flowers are very fragrant.

10. *Cydonia* Tourn. *C. vulgaris* Pers., the Quince, is a large deciduous shrub which is probably indigenous in Persia and Turkistan, but has been cultivated in Europe and Asia from very early times. The fruit is a pyriform pome covered with a grey or woolly tomentum, firm, fleshy and aromatic.

11. *Cotoneaster* Medik. This genus contains shrubs and small trees found in the hills between 4,000 and 12,000 ft.

The following is a key to the species most likely to be met with by the forest officer.

Corolla spreading, flowers opening widely, usually white:

Leaves thick evergreen, margins recurved:

Leaves elliptic, acute at both ends ... *C. buxifolia*

Leaves obovate or ovate-lanceolate ... *C. microphylla*

Leaves deciduous:

Mature leaves over 1.5 in. long:

Leaves 1.5 in. long; cymes 5-10-flowered *C. lindleyi*

Leaves up to 3 in. long; cymes many-flowered

C. bacillaris

Mature leaves under 1 in. long

C. nummularia

Corolla erect in flower; flowers not opening widely, usually pink:

Leaves hairy or tomentose:

Leaves adpressed-hairy; apex acute *C. acuminata*

Leaves tomentose beneath, rounded at the apex *C. integerrima*

Leaves glabrous or nearly so ... *C. rosea*

These species are often prostrate stiff shrubs forming mats on the soil or draped over rock. The fruit of most species is bright-scarlet, that of *C. lindleyi*, *C. bacillaris* and *C. nummularia* is bluish-black to black. The wood of the small tree *C. bacillaris* Wall. is much used for walking-sticks and is said to be excellent for tent-pegs.

12. *Crataegus* Linn. *C. oxyacantha* Linn., the Hawthorn, and *C. crenulata* Roxb. (*Pyracanthus crenulatus* (Roxb.) Rehder), are found in India, the former being confined to the north-western Himalayas and the latter to the Himalayas from the Beas eastwards (the latter has recently been found by Dr H. F. Mooney, I.F.S., to occur in central India). *C. oxyacantha* has deeply lobed and toothed leaves, the other species has coriaceous leaves.

13. *Pyrus* Linn. The spelling *Pirus* is said to be more correct. This genus of trees and shrubs is chiefly known for the two species: *P. malus* Linn., the Apple, and *P. communis* Linn., the Pear. There are, however, a number of other species in the evergreen forests of the Himalayas and eastern hills which enter into the composition of the underwood. The more important of these are the following: *P. pashia* Buch.-Ham., a very common small deciduous tree found in the hills, 2,500-8,000 ft., from Burma to the north-west. It has spreading superficial roots and reproduces with great freedom from root-suckers on steep hill-sides where the roots are exposed. The fruits, like miniature apples, are hard and gritty, but when half rotten become soft and sweet. The wood is primarily of local use. *P. sinensis* Lindl. is a moderate-sized deciduous tree, which is cultivated in the plains of northern India as the *Naspali*, or Sand Pear. The fruits are gritty and are only eaten cooked. *P. communis* Linn. does not fruit in the plains.¹

14. *Photinia* Lindl. A small genus of evergreen trees growing at temperate altitudes in the hills. The flowers are white and handsome, being borne in terminal corymbose panicles.

¹ A number of species of *Pyrus* L. have been transferred to the genus *Sorbus*. Altogether four species of *Sorbus* are found in the Himalayas: *Sorbus microphylla* (Wall.) Wenzig (*Pyrus microphylla* Wall.); *S. foliolosa* (Wall.) Spach (*P. foliolosa* Wall.); *S. wallichii* (Hook. f.) Hutch. (*P. wallichii* Hook. f.); and *S. cashmiriana* Hedlund. These species are small trees which are not found below 9,000 ft.

Besides the above there are a good many species of *Spiraea* in the hills, some of which are cultivated in gardens. *S. cantoniensis* Lour., a native of China and Japan, however, is the species most often grown. *Quillaja saponaria* Molina, a native of Chile, and *Kerria japonica* DC. indigenous to Japan, are also cultivated species.

II. CHAILLETIACEAE (DICHAPETALACEAE)

Trees or shrubs. Leaves alternate, simple, stipulate; stipules deciduous. Flowers small, mostly polygamous, actinomorphic or slightly zygomorphic, arranged in axillary or extra-axillary compact cymes. Sepals five, more or less united, imbricate. Petals five, free, notched or bifid. Stamens five, alternate with and sometimes adnate to the base of the petals; anthers 2-locular, opening lengthwise by slits. Disk of five glands, alternating with the stamens, i.e. opposite the petals. Ovary pubescent or villous, 2-3-locular. Ovules in pairs, pendulous from the top of each loculus. Fruit a villous or hispid drupe, often didymous in shape. Seeds without endosperm. Embryo large, straight.

Dichapetalum gelonioides (Roxb.) Engl. is a small tree or shrub which is found in southern and north-east India. The fruit possesses a bright red mesocarp and is globose-didymous in shape. One or two other small shrubs of the genus are found in the Andamans and southern Burma.

8. LEGUMINOSAE

Trees, shrubs or herbs; flowers hermaphrodite, subactinomorphic, zygomorphic; carpel solitary; stamens few to numerous; fruit a legume; endosperm absent.

12. CAESALPINIACEAE 13. MIMOSACEAE

14. PAPILIONACEAE

12. CAESALPINIACEAE

Trees or shrubs, sometimes climbing. Leaves pinnate or bipinnate, rarely simple or unifoliate; stipules usually absent. Inflorescence mostly of perfect racemes, or spicate, rarely cymose. Flowers showy, zygomorphic, rarely subactinomorphic. Calyx of five free sepals or the two upper connate, imbricate or valvate. Petals five or fewer or absent, the upper one inside, the others variously imbricate, often clawed. Stamens usually ten, rarely numerous, often few or aborted; filaments subulate, all of the same length or reduced; anthers usually opening by longitudinal slits, sometimes, though rarely, by apical pores. Ovary superior, 1-locular. Seeds with copious, thin or no endosperm. Embryo large.

Leaves 2-lobed or of 2 leaflets	...	1. <i>Bauhinia</i>
Leaves not as above:		
Trunk covered with branched spines		2. <i>Gleditsia</i>
Trunk not covered with spines:		
Leaves bipinnate:		
Flowers in racemes or panicles:		
Sepals imbricate:		
Pod not winged; leaflets rather small		3. <i>Caesalpinia</i>
Pod winged:		
Pod broadly winged along the upper suture		4. <i>Mezoneuron</i>
Pod produced in a wing at the apex		5. <i>Pterolobium</i>
Sepals valvate or subvalvate:		
Pod thin, flat	...	6. <i>Delonix</i>
Pod turgid, moniliform	...	7. <i>Parkinsonia</i>
Flowers in elongate racemes:		
Stamens 10	...	8. <i>Wagatea</i>
Stamens 5	...	9. <i>Acrocarpus</i>
Leaves simply pinnate:		
Petals five:		
Stamens unequal	...	10. <i>Cassia</i>
Stamens perfect, equal, usually 10		11. <i>Cynometra</i>
Petals less than 5:		
Petals 3:		
Stamens 10	...	12. <i>Amherstia</i>
Stamens 5 or less:		
Stamens 5	...	13. <i>Humboldtia</i>
Stamens 3	...	14. <i>Tamarindus</i>
Petals less than 3:		
Petal 1	...	15. <i>Intsia</i> (<i>Afzelia</i>)
Petals absent:		
Stamens 10:		
Leaflets 1 pair	...	16. <i>Hardwickia</i>
Leaflets 4-7	...	17. <i>Kingiodendron</i>
Stamens less than 10:		
Leaflets opposite	...	18. <i>Saraca</i>
Leaflets alternate	...	19. <i>Dialium</i>

¹ Milne-Redhead, in Hooker's *Icones*, sub-tab. 3460, 1947, has revived Hochstetter's genus *Pilostigma*, which differs from *Bauhinia inter alia* by being dioecious. Benthham placed *Bauhinia malabarica* Roxb. in *Pilostigma* and this name will stand provided the tree proves to be dioecious.

species found in India and Burma. They are easily recognized from the two leaflets being united for a portion of their length, forming a bilobed, palmately veined leaf. The species of this genus are not of any account in forestry but they are often met with in the forests and several species are cultivated for their flowers.

The following is a key to the common species (after Parker).

Trees:

Fertile stamens 10; pod indehiscent:

Leaves not acid; calyx spathaceous; pod rigid, falcate

B. racemosa

Leaves acid; calyx 5-cleft; pod flexible, straight

B. malabarica

Fertile stamens 3-5; pod dehiscent:

Leaves entire or notched at the apex ...

B. retusa

Leaves deeply cleft:

Leaves cleft halfway down; calyx-tube shorter than the limb ...

B. purpurea

Leaves cleft one third of the way down; calyx-tube longer than the limb ...

B. variegata

Climbers:

Leaves very large; lobes rounded ...

B. vahlii

Leaves not large; lobes acuminate ...

B. anguina

B. racemosa Linn. A small or moderate-sized tree found over the greater part of India and in the savannah tracts of Burma. It is to be found in the drier types of forest. The bark is bluish-black, rough with numerous deep vertical cracks. Blaze pinkish-red turning brown on exposure. The inner bark gives a fibre which is used for making ropes.

B. malabarica Roxb. A moderate-sized tree with a dark-brown rough bark exfoliating in long strips. Blaze pink. The leaves are acid to the taste and this characteristic easily separates this tree from the former which it somewhat resembles. It is to be found widely spread in India and Burma. This species is now known as *Ptilostigma malabaricum* (Roxb.) Benth.

B. retusa Roxb. A small to moderate-sized tree with a dark-brown, longitudinally cracked bark. Blaze pale-pink. Wide-spread in the sub-Himalayan tract and central India. It ascends to 6,000 ft. in the Himalayas.

B. purpurea Linn. An evergreen tree with grey bark. Blaze pinkish or yellowish. This tree is common in the sal forests of India. The flowers are very handsome, being deep-rose or lilac in colour, and are very fragrant.

B. variegata Linn. This is the well-known ornamental tree, the *Kachnar*. It is very frequently cultivated in gardens and alongside roads, but as it is deciduous it is not very suitable for the latter purpose. It is found wild all over India in the plains

and in the hills up to 6,000 ft. The large fragrant white or purplish flowers clothe the branches when the tree is leafless, and the tree then presents a glorious sight.

B. vahlii W. et A. This species is a gigantic climber, one of the largest to be found in the forests of India. It is known as the Camel's Foot Climber, from the close resemblance which the leaves bear to the footprint of that animal. Tendrils are found towards the ends of the branches in revolute pairs.

B. anguina Roxb. This is also a very large evergreen climber which can be easily recognized in the forests from the stems, which are not unlike a large chain made up of wooden links.

2. *Gleditsia* Linn. Several species of this genus are cultivated in India. They are readily recognized by the large branched spines on the trunks, not unlike those which decorate the stems of *Flacourtia*, and the pinnate leaves with many oblique leaflets. *G. macracantha* Desf. is often planted in gardens and as a roadside tree. *G. triacanthos* Linn. is a similar tree and is used for the same purposes. The latter has about 12-15 pairs of leaflets in the leaf, the former only 7-9 pairs.

3. *Caesalpinia* Linn. A genus containing trees or shrubs, erect or scandent, often armed with fearsome prickles. The flowers of some are handsome, others yield drugs of use in indigenous medicine, others, again, give a tanning material, while still others possess a wood from which a dye can be extracted.

4. *Mezoneuron* Desf. A genus of large prickly climbers which are common in the forests of India and Burma. The fruit is distinctive, being a flat reddish-brown pod with a broad papery wing along the dorsal suture. The flowers are a clear yellow or greenish-yellow and are produced in paniced racemes and are easily recognizable from the lowest sepal, which is much the largest and covers the others in the bud like a hood. The commonest of the four Indian species is *M. cucullatum* W. et A., a species which develops a trunk as thick as a man's arm. This trunk is covered with corky truncated cones upon the flat-topped surface of which is a sharp recurved prickle. A very conspicuous climber in the jungle.

5. *Pterolobium* R. Br. A small genus of prickly climbers. The fruit is characteristic, being a pod with one seed at the base and the rest developed into a scarlet wing up to 2 in. long.

6. *Delonix* Rafin. *Delonix regia* Rafin. (*Poinciana regia* Bojer), a native of Madagascar, is so commonly planted in India as an ornamental tree that it requires no further description. It is known as the *Gul Mohur*. The flowers of the *Gul Mohur* are described as having four scarlet petals, while the fifth, or standard, is variously variegated with gold and vermilion.

Occasionally trees having bright-yellow or apricot-coloured flowers have been reported.

7. *Parkinsonia* Linn. *P. aculeata* Linn. This tree is widely cultivated in India for its showy flowers which appear in April and May. It is a native of Mexico and the southern United States, where it is known as the *Retama* or Horse Bean. The compound leaves are prickly. It may be of use for reafforesting sandy wastes.

8. *Wagatea* Dalz. This is a monotypic genus and the only species, *Wagatea spicata* Dalz., is found in the Western Ghats. It is a woody climber with long trailing prickly branches. It has somewhat the aspect of a *Caesalpinia* but the long spikes of scarlet flowers seated on a velvety axis are very different.

9. *Acrocarpus* W. et A. *A. fraxinifolius* Wt., the only species in this genus, is a large deciduous tree found principally in the Western Ghats but extending to Assam and Burma. The adult tree usually develops large buttresses at the base. The bark is thin and light-grey in colour. The leaves are bipinnate and when young are bright-red. Fallen flowers are easily recognized from the green petals and sepals and the crimson stamens. A tree of very rapid growth.

10. *Cassia* Linn. A large genus of trees, shrubs and herbs with numerous representatives in India and Burma. Most of the tree species have cylindrical pods.

The following is a key to the tree species.

Stamens 10, antheriferous, 2-3 lower anthers different from the others:

Flowers in lax pendulous racemes, very large, yellow
C. fistula

Flowers in erect corymbose racemes, red or pink:

Flowers produced in the axils of the year's shoots

C. marginata

Flowers not produced in the axils of the year's shoots:

Flowers produced from the leaf scars on the old wood ...

C. renigera

Flowers produced in lateral racemes:

Leaflets pointed at the tips ...

C. nodosa

Leaflets rounded at the tips ...

C. javanica

Stamens 10, 6-7 only antheriferous:

Leaves without glands ...

C. siamea

Leaves with glands ...

C. glauca

C. fistula Linn. A very common ornamental tree known as the Indian Laburnum. It is wild in the deciduous forest throughout the greater part of India and Burma and can be easily recognized from the long cylindrical pods or from the very conspicuous pendulous racemes of yellow flowers. The pulp found in the pods is a very strong purgative and is officinal in

the British Pharmacopoeia. The wood is very durable and is much sought after in Assam for house-posts.

C. marginata Roxb. and the others are well-known ornamental trees to be found in almost any station. *C. siamea* Lamk. is a very fast-growing exotic species (it is a native of Malaya) which is of great use in afforesting hot arid areas. The flowers are handsome and the tree is frequently planted for ornament, but it is unsightly when old.

11. *Cynometra* Linn. A small genus of trees with characteristic leaves and fruit. The leaves are abruptly pinnate with not more than three pairs of leaflets. The midrib of the leaflet is set very obliquely so that there is a great deal more leaf surface on one side than on the other. The pods are oblique, half-orbicular, fleshy (sometimes edible), turgid, 2-valved, indehiscent.

The following is a key to the species.

Stamens 10:

Fascicles of flowers on the stem ... *C. cauliflora*

Fascicles of flowers not on the stem:

Leaflets 2-4; ovary hairy; pod turgid, rugose

C. mimosoides

Leaflets 2 only; ovary glabrous; pod flat

C. travancorica

Stamens over 10

... *C. polyandra*

C. cauliflora Linn. is a cultivated species valued as a roadside tree. The flowers are handsome, being pink and white. The fruit is said to have a flavour of apples and to be especially good when stewed. *C. polyandra* Roxb. is a large handsome evergreen, common in Cachar, Assam. The wood is said to be very useful. *C. mimosoides* Wall. (*C. ramiflora* Linn. in part) is found in the Western Ghats and the Sundarbans (Sundri-bans).

12. *Amherstia* Wall. *A. nobilis* Wall., the only species of this genus, is a Burmese tree. It has been introduced into many places in the tropics outside its own home for the sake of the astounding beauty of its vermilion and yellow flowers. It is perhaps the most beautiful of all flowering trees.

13. *Humboldtia* Vahl. Small trees or large shrubs with bipinnate leaves of 1-6 leaflets. The leaflets are rather large, prominently nerved, the nerves connected by intramarginal loops. The persistent leafy stipules are peculiar in that they consist of an erect portion and a basal, usually recurved, appendage. The species are all found as underwood in the evergreen climax forests of the Western Ghats.

14. *Tamarindus* Linn. *T. indica* Linn. is well known to everybody in India. The fruit is universally esteemed and the dried or preserved pulp is often exported. Many parts of the tree are

used in medicine and the bark contains a tanning material. This species is an excellent roadside tree and its seeds are a rich source of pectin, which is largely used in the manufacture of jams, jellies and confectionery. The latter discovery was made in the laboratories of the Forest Research Institute.

15. *Intsia* Thours. Two species of this genus, formerly wrongly attributed to the genus *Afzelia*, are common in the Andamans and Burma.

Leaves notched; pods 6-12 in. long	...	<i>I. bijuga</i>
Leaves blunt; pods 3-4 in. long	...	<i>I. retusa</i>

I. bijuga O. Ktze. (*Afzelia bijuga* A. Gray) is a medium-sized littoral tree which is highly valued for its timber. *I. retusa* O. Ktze. is taken by some to be merely a variety of the former. *I. bakeri* Prain (*Afzelia palembanica* Baker) is a large deciduous tree with conspicuous buttresses, known as the *Merbau* tree of Malacca, which has been introduced into the Andamans. It is said to be one of the best timbers found in Malaya.

16. *Hardwickia* Roxb. *H. binata* Roxb., the only species, is a moderate-sized to large, nearly evergreen tree with greyish-green coriaceous bifoliate leaves. The leaves are somewhat like those of *Bauhinia*, but the two leaflets are quite distinct. The bark of saplings is smooth and almost silvery-white, gradually changing as the tree gets older to dark-grey, and becomes rough with irregular vertical cracks and exfoliates in narrow flakes. The wood of this species is very hard and heavy, deep-red, sometimes almost black in colour. Widespread over the Indian Peninsula. Trees of this species, above 5 ft. in girth, are tapped for an oil which is used as a wood preservative. A hole is bored into the tree with an auger, about 3 ft. above the surface of the soil, and must reach the pith. A tree will give from four to sixteen gallons of oil.

17. *Kingiodendron* Harms. *K. pinnatum* Harms. (*Hardwickia pinnata* Roxb.) is a very large handsome evergreen tree reaching 100 ft. in height. Bark dark-brown and green, rather rough. This tree is confined to the evergreen climax forests of the Western Ghats from South Canara to Travancore. The wood is dark-red or reddish-brown and contains a resin, which is similar to the valuable Copaiba Balsam.

18. *Saraca* Linn. There are several species of this genus in India and Burma. The best-known of them is *S. indica* Linn., the *Asoka* tree, which is often planted for ornament or for religious purposes. It is found wild in the evergreen climax forests of the Western Ghats in Bombay State and also in Assam and Burma.

19. *Dialium* Linn. *D. travancoricum* Bourd. is an enormous evergreen tree with smooth brown bark, found in Travancore.

The pods are ovoid-globose, velvety-brown, 1-seeded. The endocarp is spongy and bright-red.

Two flowering trees, much cultivated in this country, may be mentioned. The Rusty Shield-bearer, *Peltophorum inerme* (Benth.) Llanos (*P. ferrugineum* Benth.) is a large handsome tree reaching about 80 ft. in height. It has a grey bark and bipinnate leaves, with many leaflets, deep-green and notched at the apex. The axis and branches of the inflorescence are a rusty-red in colour and the flowers a very gorgeous yellow. The copper-red pods are very numerous, and give the tree a characteristic appearance. Colville's Glory, *Colvillea racemosa* Bojer, is a moderate-sized tree rather like *Delonix regia* in general appearance when in leaf. The racemes of orange-scarlet flowers are borne well above the leaves and are very striking.

13. MIMOSACEAE

Trees or shrubs, very rarely herbs, unarmed or thorny, erect or scandent. Leaves usually bipinnate, rarely simply pinnate or reduced to cladophylls (*Acacia* spp.), or digitate; stipules free, caducous, sometimes persistent and spinescent. Inflorescence of racemes or of spikes, or flowers in spherical heads. Flowers hermaphrodite, small, actinomorphic. Calyx tubular, 3-5-lobed; lobes valvate. Petals as many as the sepals, free (*Parkia*, *Prosopis*) or more or less connate into a tube (*Acacia*, *Mimosa*, *Inga*, etc.), hypogynous. Stamens equal in number to the petals or more usually more numerous or indefinite; filaments free or connate into a tube; anthers small, round, dorsifixed; loculi opening by longitudinal slits. Stamens often gland-crested; gland deciduous. Ovary superior, 1-locular. Fruit a legume, 1 - many-locular or jointed. Seeds without endosperm; embryo straight; radicle short.

Key to the genera of *Mimosaceae*

Stamens 10; anthers with deciduous apical glands:

Plants armed; flowers in cylindrical spikes:

Pinnae 2 pairs:

Leaflets small, 7-10 pairs ...

Leaflets large, 1 pair ...

Pinnae 6-10 pairs; leaflets small ...

1. *Prosopis*

2. *Piptadenia*

3. *Dichrostachys*

Plants unarmed:

Climbers ...

Trees:

Leaflets usually alternate, 1 in. long; flowers racemose

5. *Adenanthera*

Leaflets opposite, 3-9 in. long; flowers in globose heads

6. *Xylia*

Stamens 8, 10 or many; anthers without glands:

Stamens monadelphous:

Stamens 10 ... 7. *Parkia*

Stamens indefinite:

Pods straight ... 8. *Albizzia*

Pods curved or twisted:

Pod falcate; sutures thickened ... 9. *Calliandra*

Pod circinate or twisted:

Pods not septate between seeds 10. *Pithecellobium*

Pods septate ... 11. *Enterolobium*

Stamens free:

Stamens indefinite ... 12. *Acacia*

Stamens 8 or 10:

Pod jointed ... 13. *Mimosa*

Pod not jointed ... 14. *Leucaena*

1. *Prosopis* Linn. A small genus of trees and shrubs which are important in areas of low rainfall.

There are two species in the Punjab:

Prickles small, conical; leaflets 0.5 in. long or less; pods cylindrical ... *P. spicigera*

Thorns large, subulate; leaflets 0.7-1.5 in. long; pods compressed ... *P. glandulosa*

P. spicigera Linn. This small or medium-sized evergreen tree is found in the plains of the Punjab and Madras State where the rainfall is less than 20 in. per annum. The foliage is much lopped for fodder and Parker remarks that it is difficult to find a tree which has not been mutilated. Occasionally specimens of enormous size are found, one in Jaipur being mentioned as possessing a girth of 18 ft. The pods are used as fodder. They are cylindrical in shape with a pulpy mesocarp.

P. glandulosa Torr. (*P. juliflora* DC. var. *glandulosa* Sarg.). The Mesquite. This small deciduous tree is indigenous in Mexico and the southern United States. It was introduced into India in 1878 for the sake of its pods, which in Mexico are eaten by Indians and given as fodder to cattle and horses. It has become naturalized in the Punjab. The timber is said to be almost indestructible in contact with soil, but pieces straight enough for fence posts are very rare.

P. juliflora DC. is a small evergreen tree which is cultivated in the Punjab, Madras State and Burma as an ornamental tree.

2. *Piptadenia* Benth. *P. oudhensis* Brandis is the only Indian representative of this American and African genus. The species is a middle-sized tree found in the Gonda and adjacent districts. The leaves consist of two pairs of pinnae, each pinna bearing two reniform subcoriaceous leaflets. There is a superficial resemblance in the leaflets to those of *Hardwickia binata*

Roxb. but in the latter it will be remembered that the leaves are simply pinnate and not bipinnate.

3. *Dichrostachys* DC. *D. cinerea* W. et A. is a rigid thorny shrub or small tree with a longitudinal furrowed bark which grows in the hotter and more arid parts of India. The flowers are borne in cylindrical peduncled spikes. The upper flowers are hermaphrodite and yellow in colour, the lower are neuter with long pink or purple stamens. The wood is red streaked with black, very hard and tough, and is said to be a good fuel wood.

4. *Entada* Adans. The Indian species is *E. phaseoloides* Merr. (*E. scandens* Benth.) St. Thomas' Bean. A gigantic climber with enormous pods up to 4 ft. long, found in north-east and eastern India in areas of high rainfall. The trunk of this species contains plentiful quantities of water which can be obtained by cutting sections of the stem. The tissues, especially the bark, contain saponins, which are fatal to fish, and the creeper is often used for the purpose of killing fish in the Philippines.

5. *Adenanthera* Linn. *A. pavonina* Linn. is a handsome deciduous tree of eastern India and Burma. This tree is easily recognized by its scarlet seeds which fall tardily from the twisted valves of the pod. These scarlet seeds are known as Barricari seeds and are used by Indian goldsmiths as they constantly weigh about 4 grains. The bipinnate leaves with the red rachis and alternate leaflets are striking. The wood is reddish-brown, hard and close-grained. It is known in the trade as Red Sandal wood, Coral wood or Condori wood.

6. *Xylia* Benth. This important genus is represented in India by two species to which the following is a key.

Anthers not gland-crested	... <i>X. dolabriformis</i>
Anthers gland-crested	... <i>X. xylocarpa</i>

X. dolabriformis Benth. is the Ironwood or *Pyinkado* of Burma. This is a very large deciduous tree with a thin, yellowish or reddish-grey bark exfoliating in irregular rounded plates. It is one of the most important timber-trees of Burma. The pods are quite distinctive, being 4-6 in. long and oblong-falcate in shape.

X. xylocarpa Roxb. is a moderate-sized to large deciduous tree which is usually found in the western side of India but penetrates eastwards to the State of Orissa and into Madhya Pradesh. The bark is smooth, reddish-grey in colour, exfoliating in large irregular plates. It is a much smaller species than the Burmese *Pyinkado*.

7. *Parkia* R. Br. There is one species of this genus in India, very easily recognized in the field. The leaves are bipinnate with very numerous leaflets. The long, flat, ripe pods hang in a bunch from the tip of the pendulous peduncle. The flowers,

moreover, are peculiar. They are arranged in heads, the upper flowers being hermaphrodite and the lower male or sterile. The interior of the seed-pods is filled with a spongy endocarp which turns bright-yellow at maturity, is sweet and retains its sweetness when dried. The pods including the seeds are eaten and may be seen in the vegetable markets of Burma and Manipur State. The Indian species is *P. javanica* Merr. (*P. roxburghii* Don).

8. *Albizzia* Dur. A rather large genus containing many species, distributed throughout the tropics of the Old World. There are a number of species in India which are typically inhabitants of the deciduous type of forest.

The following is a key to the species likely to be met with by the forester.

Erect trees:

Pinnae 1 pair, rarely a second weaker pair; leaflets 2-6 in. long ... *A. lucida*

Pinnae 2-12 pairs:

Pinnae 2-6 pairs:

Flower-heads paniced, flowers sessile:

Leaflets 6-10 pairs 0.75-2 in. long; midrib near the lower edge ... *A. procera*

Leaflets 10-35 pairs:

Leaflets 0.75-1 in. long, 10-25 pairs somewhat falcate ... *A. odoratissima*

Leaflets oblong, less than 1 in. long, 25-30 pairs ... *A. lebbekioides*

Flower-heads from the upper leaf axils:

Leaflets 3-10 pairs; pods straw-coloured ... *A. lebbek*

Leaflets 12-22 pairs; pods brown ... *A. kalkora*

Pinnae 6-12 pairs:

Stipules conspicuous ... *A. chinensis*

Stipules minute ... *A. julibrissin*

Climber ... *A. myriophylla*

A. lucida Benth. is a tree of eastern India with much larger leaflets than the others.

A. procera Benth. is a large deciduous tree, conspicuous because of its yellowish-white bark often stained with brown. The wood is valuable. A very common tree in secondary forest on alluvial soil. Very common in Assam in riverain forest.

A. odoratissima Benth. This large tree is conspicuous in the forest because of its sweet-smelling white flowers and yellow filaments. The wood is sometimes known as Ceylon Rosewood, and is useful for many purposes, especially for furniture.

A. lebbekioides Benth. is an enormous tree found in Upper Burma and said to be common there. The bark yields a substance used in tanning.

A. lebbek Benth. is found all over India. It is a moderate-sized to large deciduous tree with a dark-grey rough bark, crimson inside. Burrs are sometimes formed on the bole and are valuable as they can be sliced into well-figured veneers. The timber is dark-brown with lighter or darker streaks. It is valued for a variety of purposes.

The other species are not of much importance. *A. chinensis* Merr. is the correct name for *A. stipulata* Boiv. *A. myriophylla* Benth., the climber, is sometimes used as a medicine. *A. gamblei* Prain has been proved by R. N. Parker to be a hybrid between *A. lebbek* Benth. and *A. lucida* Benth.

9. *Calliandra* Benth. This is a genus of small trees or shrubs, exotic species of which are sometimes in cultivation as ornamental plants. There are a few indigenous species, of which *C. cynometroides* Bedd., now known as *Inga cynometroides* Bedd., is the most important.

10. *Pithecellobium* Mart. is a genus of trees and shrubs often found in the evergreen climax forests of India and Burma.

Stipules spinose:

Pinnae 1 pair, each with 1 pair of leaflets *P. dulce*

Pinnae 1-2 pairs, each with 5-8 pairs of leaflets

P. umbellatum

Unarmed:

Leaflets numerous; pinnae 4-12 pairs:

Leaflets 0.5-1 in. long ... *P. montanum*

Leaflets 0.25-0.3 in. long ... *P. subcoriaceum*

Leaflets few; pinnae 2-5 pairs; leaflets 1-4 pairs:

Rhachis of pinnae angled ... *P. angulatum*

Rhachis not angled:

Pinnae 1 pair ... *P. lobatum*

Pinnae 2-3 pairs ... *P. bigeminum*

The species of the genus have characteristic pods. They are spirally twisted or curved in a circle, dehiscing elastically along the lower suture. *P. dulce* Benth. (*Inga dulcis* Willd.), when allowed to grow, reaches tree size, but it is usually kept clipped and makes a good strong spiny hedge. It is indigenous in America but has become naturalized in various parts of India. The pods are relished by cattle and goats browse the foliage.

P. umbellatum Benth. is a low tree with thick moniliform pods and heads of sparse pedicelled creamy-white flowers with very long stamens. It is found in the southern parts of the Deccan Peninsula.

P. montanum Benth. is an evergreen tree of Assam and northern Burma with grey to dark-brown bark, rather rough. Blaze red. The small trapeziform leaves and spirally twisted lobed pods distinguish this species in the field.

P. subcoriaceum Thw. is a small tree indigenous in the

Western Ghats and southern India, with a smooth grey bark and spreading branches. The flowers are greenish-white, covered with a golden pubescence. The pods are bright-orange in colour and curved in a circle. A striking tree with handsome foliage.

P. angulatum Benth. is a small to middle-sized tree with dark-brown or grey bark, red to reddish-brown inside. The sharply angled branches and spirally twisted pod, red inside, are characteristic of this tree. It is very common in evergreen forest in Sikkim, Assam and Burma. The leaf is used with the fruits of *Terminalia chebula* to dye cloth black.

P. lobatum Benth. is a middle-sized tree indigenous to Burma, where it is often planted for ornament. The bark is slightly rough, minutely fissured, with a dryish reddish-brown blaze. The pods are spirally twisted and the seeds are edible.

P. bigeminum Mart. is a moderate-sized tree of eastern India where the rainfall is heavy. The bark is similar to that of the other species of this genus and with a similar blaze. The pod is similar to that of *P. angulatum* in that it is twisted and red inside. The larger leaves and non-angled rhachis serve to separate this species from the other.

11. *Enterolobium* Mart. The Rain tree, *E. saman* Prain,¹ is a well-known avenue-tree in India, where it grows to a very large size. The pods contain a little edible pulp and are readily eaten by cattle. It has obtained its trivial name from the fact that the leaflets fold together during a rain-storm. *E. timbouva* Mart. is also planted in India as an ornamental tree. It is a native of Brazil and has characteristic pods. These are semi-circular in shape and concavo-convex.

12. *Acacia* Willd. A very large genus containing numerous species of trees and climbers. The genus finds its greatest expression in Australia and Africa, but India also contains a goodly number of species and in addition a number have been imported for various purposes.

The following is a key to the tree species.

Mature leaves represented by phyllodes ... *A. melanoxylon*

Mature leaves bipinnate with many leaflets:

Flowers yellow, very fragrant:

Foliage silvery ... *A. dealbata*

Foliage green:

Unarmed tree ... *A. decurrens*

Prickly tree ... *A. farnesiana*

Flowers not fragrant and mostly not yellow:

Flowers in globose heads; peduncles 2-bracteate:

Pod grey, downy, dented on both sides between the seeds ... *A. arabica*

¹ Also known as *Samanea saman* (Jacq.) Merr.

- Pod cylindrical, turgid, usually curved *A. planifrons*
 Pod flattened; spines white:
 Leaves glabrous; peduncles filiform:
 Spines straight, often white *A. eburnea*
 Spines: some short, recurved, others long,
 straight, white ... *A. roxburghii*
 Leaves hairy; peduncles stout:
 Leaves under 1 in. long; 6-10 pairs of pinnae;
 long spines slender, white, up to 1.25 in. long
 A. campbellii
 Leaves up to 3.5 in. long, 6-12 pairs of pinnae;
 spines stout, up to 2.5 in. long *A. tomentosa*
 Pod unknown; spines brown ... *A. wightii*
 Flowers in spikes or panicles:
 Flowers in panicles ... *A. leucophloea*
 Flowers in spikes:
 Spines up to 2 in. long ... *A. latronum*
 Spines short, hooked:
 Pinnae 10 pairs or more:
 Branches brown; calyx, petals and leaf-rhachis
 pubescent ... *A. catechu*
 Branches red; calyx, petals and leaf-rhachis
 glabrous ... *A. chundra*
 Pinnae 5 pairs or fewer:
 Prickles in threes ... *A. senegal*
 Prickles in pairs ... *A. modesta*

A. melanoxyton R. Br. The Australian Blackwood is a middle-sized tree which reaches a height of 80 ft. in the Nilgiris. The dense olive-green foliage, consisting mainly of phyllodes and not of true leaves, make it a very handsome tree, very different in appearance from the other species of *Acacia* in India. The phyllodes are falcate, coriaceous, glabrous, up to 4 in. long. The timber is valuable, dark-brown in colour and beautifully mottled. The bark contains tannin.

A. dealbata Link is also known as the Silver Wattle. A small evergreen tree with hoary, very handsome branchlets and foliage. In its own home it reaches a height of 150 ft. but in the Nilgiris, where it was imported in the early forties of the last century, it does not attain more than 50 ft. The fragrant yellow flowers make it a desirable addition to a garden. It is largely planted in Shillong where it is known as the Silver Mimosa. The bark is valued for its tannin content.

A. decurrens Willd. is another of the *Acacias* introduced into the Nilgiris. It is known as Green Wattle. It is similar to *A. dealbata* and was at one time considered to be merely a variety. The bark is used in tanning.

A. farnesiana Willd. This small tree, hardly 12 ft. in height, is cultivated everywhere in the tropics for the sake of its yellow fragrant flowers. It is probable that it was introduced into India from South America. Lac can be grown upon this tree. The bark also possesses a tannin.

A. arabica Willd., the *Babul*, is a moderate-sized almost evergreen tree with a dark-brown or black bark with regular long longitudinal fissures which very often run spirally up the tree. Blaze hard, pinkish-brown. This tree is indigenous to Sind, the Deccan and tropical Africa. It has been extensively planted in the Punjab plains and has become thoroughly naturalized there. The pods are 3-6 in. long, stipitate, moniliform, densely grey-tomentose. The pods when unripe are rich in tannin and the bark is also used for tanning. The branches are lopped for feeding goats and camels and are used for fencing fields. From wounds in the bark a gum exudes which is used in place of, though much inferior to, Gum Arabic. Lac is grown on this tree in Sind.

A. planifrons W. et A., known in Madras State as the Umbrella Thorn, is a small to moderate-sized tree with a flat spreading dense umbrella-like crown. It is found in dry types of forest associated with other species of the *Mimosaceae* and *Chloroxylon swietenia*. The wood is hard and heavy but is not much used.

A. eburnea Willd. is a large shrub or small tree with rough dark-grey bark. It is confined to the drier parts of the sub-Himalayan tract where it occurs with other mimosaceous species, e.g. *A. catechu*, *A. leucophloea*, *A. latronum*, etc. The yellow heads of flowers have an objectionable odour.

A. roxburghii W. et A. Little is known about this little tree, apart from the fact that the flowers are yellow and set on very short peduncles. It is confined to Madras State. The same remarks apply to *A. campbellii* Arn. except that the flowers are pink.

A. tomentosa Willd. A small tree confined to Madras State. The spines are large and broad-based and the flowers are greenish-white.

A. wightii Bak. A small tree with long stout dark-brown spines.

A. leucophloea Willd. A moderate-sized deciduous tree with a bark which is pale-grey and smooth on young stems, dark-brown, blackish and rough on old stems, exfoliating in irregular scales. Blaze light-red. This tree is found in the drier parts of Uttar Pradesh, Punjab, Burma and Madras State. The wood is not of any account. It is easily distinguished from other species by the paniculate inflorescence.

A. latronum Willd. This is a small gregarious and thorny shrub resembling *A. planifrons* in appearance but it is much

smaller. It is interesting for the reason that it is what is known as a myrmecophilous species, in that it possesses thorns¹ which are hollow and often tenanted by large black ants. This tree is found in the drier and hotter parts of southern India.

A. catechu Willd. A small or medium-sized deciduous tree with dark-grey bark which exfoliates in long narrow rectangular plates. Blaze brown and red. In eastern India this tree is often found on sandy river banks forming a characteristic association with *Dalbergia sissoo*. In the outer Himalayas it is a tree of dry hill-slopes. The heartwood is dark-red, hard and is not eaten by white ants. The wood contains tannin, and after boiling the extract known as *Cutch* is obtained.

A. chundra Willd. (*A. sundra* DC.). This species, known as *Red Kutch*, achieved considerable notoriety during the war because it was found that its timber compared very favourably with that of the famous *Lignum-vitae* (*Guaiaecum officinale*) from the West Indies and the northern coast of South America. *Lignum-vitae* has been known for many years as one of the hardest, heaviest, and closest-grained timbers. Owing to the very high percentage of resin, insoluble in water, in the wood, it is a self-lubricant and resistant to sea-water, while its great compressive strength makes it of high value for pressure bearings. The fact that a timber is found in India which has all these desirable characters in equal degree is an event of high importance. *A. chundra* Willd. had long been considered to be a variant of *A. catechu* Willd.²

A. senegal Willd. A small thorny tree with pale greenish-grey bark which exfoliates in flakes and exposes the yellow new bark beneath. In habit and appearance this tree resembles *A. modesta* but is easily distinguished from it by the smooth pale bark, its infra-stipular spines in threes, and its large pods. It is confined to the arid regions of India.

A. modesta Wall. A moderate-sized tree with a bushy rounded crown and drooping branchlets. Bark rough with numerous irregular cracks. This species can be grown as a thorny hedge which is most efficient. Such a hedge can only be grown from seed. It requires clipping only two or three times a year and is so strong and thickset that it will keep even buffaloes out of a garden.

A large number of the Australian acacias have been introduced into gardens, especially those which possess phyllodia.

¹ See *Hydnophytum formicarium*, *Rubiaceae*, another myrmecophilous species.

² It is so treated in *Indian Trees*, by Brandis.—M. B. Raizada gives a good key to these species in *Ind. For.*, vol. 70, p. 437.

They are esteemed for their handsome, somewhat peculiar, foliage.

The species which have been considered up to the present are trees or shrubs. Several species, however, are well-known climbers and a number of them do considerable damage in sal and other dry forests.

The key to the Indian species, *Caesia* group, is from R. N. Parker (*Ind. For.*, vol. 55, p. 325).

Pods flat:

Leaflets distant or touching:

Glands on the petiole always solitary; bracteoles not acuminate:

Petiolar gland flat or conical:

Flower-heads in bud pubescent:

Leaflets rather distant, 6-14 pairs on each pinna
A. caesia

Leaflets close and touching, usually 25-40 pairs
 on each pinna ... *A. torta*

Flower-heads in bud glabrous or nearly so:

Leaflets close and touching, 1-nerved, the second
 nerve weak and scarcely reaching half-way
 up the leaflet ... *A. gageana*

Leaflets not touching, rather strongly 2-nerved
 near the apex ... *A. oxyphylla*

Petiolar gland columnar ... *A. columnaris*

Glands on the petiole usually two; bracteoles long-
 acuminate, very conspicuous in young flower-heads
A. diadenia

Leaflets overlapping:

Pod 6-8 in. long; sometimes thick ... *A. pennata*

Pod 4 in. long; suture slightly round ... *A. canescens*

Pods thick, fleshy, much wrinkled:

Pinnae 4-6 pairs; leaflets 18 pairs ... *A. rugata*

Pinnae 8 pairs or more; leaflets more than 20 pairs
A. concinna

13. *Mimosa* Linn. A very large genus of trees and shrubs, found chiefly in America, but a few are Asiatic and African. There are a few species in India but these species are of little interest to the forester. *M. himalayana* Gamble (*M. rubicaulis* Lamk.) is very common in mixed deciduous forest or in waste land and savannah, and particularly so about Dehra Dun. *M. pudica* Linn., the Sensitive Plant, is a small prickly under-shrub with very sensitive leaves, pink flowers and bristly pods. It is a South American plant.

14. *Leucaena* Benth. The Lead Tree. The species found in India is *L. glauca* Benth., a small tree or large shrub indigenous to South America but naturalized here and there in this country

where it spreads readily from self-sown seed. Some years ago this plant was in great demand in tea-plantations, where it was valued for the sake of the nodules it produces on its roots. R. N. Parker carried out some experiments at Dehra Dun in 1929 in order to see whether the introduction of a special strain of bacteria would improve the growth of this species in northern India (*Ind. For.*, vol. 55, p. 641). The tests went to prove that bacteria-impregnated soil from plantations of the species in the Philippine Islands was greatly to the benefit of the *Leucaena* grown elsewhere. The utility of this species for afforesting grass-lands in order to prepare the way for the introduction of timber-trees has been proved in the Philippines where it can grow on equal terms with *Imperata cylindrica*, eventually ousting it (Troup).

14. PAPILIONACEAE

Trees, shrubs or herbs. Leaves simple or compound, opposite or alternate, often terminating in tendrils, sometimes absent and replaced by foliaceous stipules or by wings on the stem. Inflorescence of racemes, spikes, heads, umbels or of solitary flowers. Flowers zygomorphic, hermaphrodite. Calyx of five sepals more or less connate into a tube, more or less irregular, sometimes 2-labiate. Disk present, lining the calyx-tube. Petals five, the upper (adaxial) exterior and forming the standard, the two lateral (the wings) more or less parallel with each other, the lower two interior and connate by their lower margins into a keel, inserted on the disk with the stamens. Stamens usually ten, mostly all perfect; filaments monadelphous or diadelphous, or sometimes all free (*Sophora*). Ovary 1-locular, sessile or stipitate, usually several-ovuled; ovules seated on the suture facing the standard; style filiform; stigma terminal or lateral. Fruit usually a pod, sometimes moniliform (*Sophora*). Seeds mostly without endosperm.

Key to the genera of *Papilionaceae*

- Spiny shrubs with yellow flowers and digitate or paripinnate leaves ... 1. *Caragana*
- Shrubs and trees not as above:
 - Shrubs with connate stipules ... 2. *Piptanthus*
 - Shrubs or trees without connate stipules:
 - Stamens free:
 - Leaflets opposite, mostly coriaceous; pod fleshy or woody ... 3. *Ormosia*
 - Leaflets often alternate; pod moniliform ... 4. *Sophora*
 - Stamens monadelphous or diadelphous:
 - Seeds bright-scarlet with a black spot at one end ... 5. *Abrus*

Seeds not as above:

Pod continuous, not articulate:

Pod indehiscent, usually large, few seeded:

Leaves pinnate:

Pod not winged:

Leaflets opposite ... 6. *Pongamia*

Leaflets alternate ... 8. *Dalbergia*

Pod with a narrow wing or wings:

Pods oblong ... 7. *Derris*

Pods irregularly orbicular; seed solitary,
central ... 9. *Pterocarpus*

Pod dehiscent:

Leaves pinnate:

Pods not chambered inside 10. *Milletia*

Pods chambered inside:

Connective topped by a gland

11. *Indigofera*

Connective glandless ... 12. *Sesbania*

Leaves simple or digitately 3-foliate:

Pods inflated ... 13. *Crotalaria*

Pods not inflated:

Pod indehiscent, bearing the seed at the
upper end; the lower end wing-like ex-
panded and sterile:

Flowers large, yellow or orange, race-
mose ... 14. *Butea*

Flowers small, in ample terminal
panicles ... 15. *Spatholobus*

Pod dehiscent:

Trees with prickles; leaves not gland-
dotted beneath ... 16. *Erythrina*

Shrubs without prickles; leaves gland-
dotted beneath ... 17. *Flemingia*

Pods articulate:

A tree; flowers fasciculate on old wood

18. *Ougeinia*

Shrubs; flowers racemose or paniced

19. *Desmodium*

1. *Caragana* Lam. A genus of shrubby species with paripinnate leaves and spiny branches. The rhachis of the leaves usually ends in a persistent spine. The species are confined to the north-west Himalayas and to central Asia and China, some of them being fairly frequent in moderately dry forest undergrowth. None of them is found below 8,000 ft.

Parker gives the following key to the Punjab species.

Leaflets crowded, more or less digitate ... *C. pygmaea*

Leaflets imparipinnately arranged:

Flowers subsessile:

Stipules coriaceous, amplexicaul, persistent

C. gerardiana

Stipules scarious, free, deciduous ...

C. sukiensis

Flowers peduncled:

Calyx-teeth lanceolate, cuspidate; pod woolly within

C. brevispina

Calyx-teeth subulate; pod glabrous within

C. decorticans

2. *Piptanthus* D. Don. *P. nepalensis* D. Don is found above 6,000 ft. in the Himalayas and in the hills between Assam and Burma. It has pretty yellow flowers and has been introduced into Indian gardens. In its native home it is often found growing gregariously in the undergrowth of moist hill-forest. The stipules are connate, about 0.5 in. long or longer, and appear to be opposite to the petiole.

3. *Ormosia* Jack. A small genus of lofty evergreen trees with imparipinnate leaves and characteristic pods and seeds. *O. robusta*, found in the evergreen climax forests of Assam and Burma, is a tall tree. The pod is bright-yellow in colour and contains two glossy-black seeds entirely enveloped in a scarlet arillus. *O. travancorica* Bedd. is indigenous in the Western Ghats forests but here the pod is bright-red and contains one red seed.

4. *Sophora* Linn. A small genus of trees and shrubs, some of which are cultivated in gardens for their pretty flowers and foliage. The pods of the various species are moniliform and therefore are a reliable guide to the diagnosis of the species of this genus in the forest. The species are divided into two sections according as the pod is without wings or has wings. *S. griffithii* Stock belongs to the latter section. It is an inhabitant of the drier parts of north-west India and is gregarious in the juniper forests of Baluchistan.

5. *Abrus* Linn. *A. precatorius* Linn. is the best-known species of this genus. It is a common climber and is found all over India and Burma, ascending in the Himalayas to 3,000 ft. The seeds of this species are bright-scarlet in colour with a black spot at one end. These seeds, when gathered fully ripe, retain their original bright colour to a remarkable degree and are used to cover bags and as necklaces. The seeds themselves are exceedingly poisonous and are sometimes utilized by criminals to poison cattle and human beings. The active principle of liquorice, glycyrrhizin, is found in the roots and leaves. The seeds are used by Indian jewellers as a weight; each is said to weigh 1.75 gr.

6. *Pongamia* Vent. A small genus of trees of which one, *P.*

pinnata Pierre (*P. glabra* Vent.), is common in India. The bark is smooth, grey and yellowish inside. The timber of this species is of no account and is used mainly for fuel. The seeds, however, yield a thick yellow or red-brown oil which is used as an illuminant. The pod of the species is quite distinctive being woody and indehiscent. This tree is very easily raised from seed or cuttings and is largely planted for shade and in gardens.

7. *Derris* Lour. A genus of trees and climbers found everywhere in India except in the very dry parts. *D. robusta* Benth. is a middle-sized tree with a light yellow bark, very common in the sal forests of eastern India, and often grown as a shade-tree in tea-gardens in Bengal and Assam. Several of the species are used as fish poisons and this led to their examination for substances suitable for insecticides. *D. ferruginea* Benth., a climber common in the evergreen forests of Bengal and Assam, has been found to contain the valuable rotenone. *D. elliptica* Benth. is, perhaps, the best known of rotenone-yielding plants and this climber is now being cultivated in various parts of this country. The species of *Derris* are easily recognized by their pinnate leaves and *Dalbergia*-like pods which, however, are quite flat and winged on one or on both sides.

8. *Dalbergia* Linn f. A large genus with many species in India and Burma, a few of them trees and the remainder climbers. They can be easily recognized in the forest by the compound leaves with alternate leaflets and the oblong flat indehiscent wingless pods.

The following is a key to the tree species found in India.

Stamens monadelphous, usually 9:

Leaflets 3-5, acuminate-cuspidate	...	<i>D. sissoo</i>
Leaflets 5-7, obtuse or emarginate	...	<i>D. latifolia</i>

Stamens diadelphous, 5+5:

Leaflets with prominent parallel nerves	...	<i>D. lanceolaria</i>
Leaflets with reticulate venation	...	<i>D. paniculata</i>

D. sissoo Roxb. This is a large gregarious deciduous tree with a thick grey bark, longitudinally and somewhat reticulately furrowed. Its home is in the sub-Himalayan tract and it typically prefers alluvial soil, coarse or fine. It is, however, extensively planted outside this area as a roadside tree, for which it is favoured on account of the ease with which cuttings strike. Its deciduous habit, however, militates against its being the perfect roadside tree. At New Forest, in the grounds of the Forest Research Institute, it springs up like a weed. The timber is very durable and seasons well, neither splitting nor warping. It is excellent as a furniture wood and for carving. The fragrant cream-coloured flowers are produced in profusion in spring.

D. latifolia Roxb. A large deciduous (almost evergreen) tree growing in the sub-Himalayan tract from Oudh to Sikkim and also in central, western and southern India. It attains its best dimensions in the Western Ghats and in the fairly moist deciduous forests of Madras State. The bark is thin, grey, exfoliating in thin longitudinal flakes. The leaflets are much rounder than those of *D. sissoo* and the two trees should not be confounded. The timber, which is known in the trade as Indian Rosewood or Bombay Blackwood, is prized as a veneer for panelling, ordnance work, etc.

D. lanceolaria Linn. A large and handsome deciduous tree found in the deciduous monsoon forests of Bombay and Madras States. The bark grey and smooth; the wood of no great value.

D. paniculata Roxb. A large deciduous tree with a conspicuously light-coloured smooth bark. The timber is of no importance.

9. *Pterocarpus* Linn. This genus is an important one for the forester, for it contains some very valuable trees. The genus can be easily recognized from the ovate, falcate or orbicular winged 1-seeded fruit.

The five species in India and Burma can be separated by the following key (Prain, *Ind. For.*, vol. 26, Appendix).

Leaves thinly coriaceous, quite glabrous beneath when old; pods, even when young, only sparsely puberulous; racemes paniculate:

Leaves ovate-lanceolate, narrowed gradually to a point, with 5-7 pairs of nerves distinctly raised beneath; panicles almost wholly terminal, only extending into the axils of 2-3 leaves; bracteoles ovate; edge of pod between stipe and style usually concave

P. dalbergioides

Leaves ovate, abruptly rounded to a blunt point; nerves beneath hardly more prominent than secondary veins; panicles almost all axillary, only one terminal; bracteoles lanceolate; edge of pod between stipe and style convex

... *P. indicus*

Leaves firmly coriaceous, finely pubescent beneath; pods, when young, velvety:

Flowers axillary in simple or sparingly branched racemes:

Leaflets 6-9, ovate, bluntly acuminate, mucronulate; pedicels considerably longer than the calyx

P. macrocarpus

Leaflets 3 (rarely 4-5), roundish, retuse or obtuse; pedicels not exceeding calyx ... *P. santalinus*

Flowers in terminal panicles; pedicels shorter than calyx; leaflets 5-7, retuse, obtuse, acute or acuminate

P. marsupium

P. dalbergioides Roxb. This species furnishes the timber known as Andaman Redwood in the trade. It is common in the Andamans, sparingly cultivated in gardens in Bengal. It is a very large deciduous tree, often with large buttresses. This tree is not gregarious but is found scattered in mixed deciduous or semi-evergreen forests in the Andamans. When blazed there is an exudation of blood-red juice. The timber is used for a large number of purposes and varies in colour from light-brown to a gorgeous red.

P. indicus Willd. This tree is believed to be indigenous in the Malay Peninsula and to have been introduced into Burma where it is largely planted along roadsides and avenues. It is sometimes known as *Malay Padauk*. It is not considered to be of any importance as a timber tree, but it deserves to be more widely cultivated for its yellow or orange, fragrant flowers.

P. macrocarpus Kurz. This tree is the source of Burma Padauk, a timber well known and sought after in European markets. This species sometimes reaches a height of 100 ft. but more often its limit is under 70 ft. The bark is grey, exfoliating in irregular scales, exuding when blazed a bright-red astringent gum similar in appearance to the kino of *P. marsupium*. The sap-wood is light yellowish-brown while the heartwood is bright yellowish-red to brick-red often streaked and mottled with brown.

P. santalinus Linn. f. This species is a small to middle-sized tree and is usually known as Red Sanders. The bark is blackish-brown, divided by deep vertical and horizontal cracks into rectangular plates. The blaze exudes a red juice. The home of the tree is very restricted, it being confined to the Cuddapah district of Madras State, where it grows in stony country in company with *Chloroxylon swietenia*, *Terminalia* spp., *Hardwickia binata*, *Albizia* spp., etc., and with tufts of *Cymbopogon citratus* as undergrowth. The wood of this tree is extremely hard, dark-red to almost black in colour and is used widely for house-posts. Formerly it yielded a dye.

P. marsupium Roxb. A large deciduous tree inhabiting the greater part of the Indian Peninsula extending to the bhabar of Uttar Pradesh. It is to be found scattered in deciduous forests. The bark is grey, exfoliating in small irregular scales. The blaze is pink with whitish markings, and old trees exude a blood-red astringent gum from the cut. The wood is brown, hard and durable, and is much in demand. The exudation from the bark is a blood-red or ruby astringent resin which is known as *Malabar Kino* and is the officinal kino of the British Pharmacopoeia. It is given in cases of diarrhoea and dysentery. In recent years the belief that infusions of the wood, or even drinking water from a cup made of the wood, are a specific for diabetes has become widespread. Many firms specialize

in the making of cups from the wood which are sold to sufferers from this disease. Clinical tests are said to have shown no improvement in cases treated with an infusion of this wood.

10. *Millettia* W. et A. A genus of trees and shrubs with many species, found throughout the warmer parts of the world. There are many species in India. The flowers are often borne in ample racemes or panicles and are white, pink or purple in colour and are sometimes produced in such profusion that the trees and climbers are desirable plants in a garden. The large majority of the tree species are indigenous in Burma, only a few having succeeded in reaching the eastern parts of the Indian Peninsula. One of these is the tree *M. atropurpurea* Benth., which has been found in Chittagong. Besides being very handsome when in flower, there is a poisonous principle in the roots. The climbers are for the most part common to both areas. *M. auriculata* Baker, one of the commonest climbers in the sal forests of Assam and Bengal, contains a toxic principle in the roots which is used to kill maggots in cattle sores. Its thick bark also serves to make rough ropes. *M. pachycarpa* Benth., a large creeper of eastern Bengal and Assam, contains rotenone, the well-known insecticide. It is often used as a fish poison by the hill-tribes.

11. *Indigofera* Linn. A large genus of herbs and shrubs, widely spread throughout the tropics and well represented in India. It includes certain species which contain Indigo, from which it has obtained its name. According to Burkill, there is no dye in the world of wider consumption and few more permanent. The dye has been known from very ancient times since it is proved to have been used for staining mummy clothes found in the ancient Egyptian tombs. The genus can often be recognized by the cylindrical pods, pointed at both ends; some species have, however, globose pods.

12. *Sesbania* Pers. There are several species common in India.

Flowers 2-3 in. long	...	<i>S. grandiflora</i>
Flowers less than 1 in. long:		
Woody perennials	...	<i>S. sesban</i>
Annuals:		
A low shrub	...	<i>S. bispinosa</i>
An erect shrub	...	<i>S. cannabina</i>

S. grandiflora Pers. This is a small, quickly growing tree with large white or reddish flowers. It is often cultivated in gardens for its pretty flowers and foliage but rarely lasts more than three years and is said to grow best on black cotton soil. Many parts of the plant are medicinal.

S. sesban (Linn.) Merr. (*S. aegyptiaca* Pers.) A short-lived small tree which is often used as a nurse for other plants. The

form with yellow flowers is considered to be the type, while that with the purple-dotted standard is called var. *picta* Prain, and that with the deep purple or black standard var. *bicolor* W. et A.

S. bispinosa (Jacq.) Fawcett et Rendle (*S. aculeata* (Willd.) Pers.). A large erect shrubby annual which springs up gregariously on waste places.

S. cannabina Pers. A tall, slender, annual herb cultivated in Bengal under the name of *Dhaincha* for the sake of its fibre, which is said to be strong and useful and is used locally for fishing-lines and nets.

All of these species possess large nodules on the roots and are of use, at least the smaller species, as green manures. The last named is often used by tea-planters in Bengal and Assam as a shade and green manure crop.

13. *Crotalaria* Linn. A very large genus of herbs and somewhat woody shrubs of which many species are found in India. It is an easy genus to spot in the forest, for the pods are much inflated and moreover the flowers of most species are a clear bright-yellow. A number of species have been tried as green manure. *C. juncea* Linn., *San-* or *Sunn-hemp*, is a plant which has been cultivated in India for its fibre from very ancient times. *C. striata* DC., another common Indian species, has been widely used, at least in Malaya, as a green manure and is highly esteemed.

14. *Butea* Roxb. A small Indian genus containing a tree, a shrub and two climbers.

Flowers very large (1.5-2 in. long), red; keel incurved, acute:

Tree; lower calyx-teeth deltoid ... *B. monosperma*

Large climber; lower calyx-teeth lanceolate *B. superba*

Flowers less than 1 in. long:

Large shrubs; flowers red ... *B. minor*

Climber; flowers small, white ... *B. parviflora*

B. monosperma O. Ktze. (*B. frondosa* Roxb.). The *Palas* or *Dhak*. A small deciduous tree with a crooked trunk and black nodose branches, common in northern and central India and also in Burma. The flowers are scarlet and orange and are borne in great profusion on the leafless branches. Occasionally trees with white, apricot or bright-yellow flowers are reported. Another variety which has been recorded has simple instead of trifoliate leaves. A red juice issues from the blazed tree and hardens into a red astringent gum of use in the treatment of diarrhoea and in the indigo-heating vats in Bihar. According to Haines it is supposed to increase the out-turn of indigo by 30-40 per cent. The flowers give a dye, the bark a tanning material, while the tree itself is one of the principal hosts for the lac-insect.

B. superba Roxb. This species is a very large, deciduous, woody climber which is found in central and southern India and also in Burma. The flowers, orange-scarlet in colour, are borne in great profusion on the leafless branches, presenting a picture of unparalleled beauty. It, like *B. monosperma*, also yields a reddish juice when blazed. Lac can also be grown on this species.

B. minor Ham. An interesting shrub with long sarmentose branches. It is found in central India, Bihar, Sikkim and the Naga Hills. It is a handsome plant when in flower, the long paniced racemes of red flowers being well shown off by the glossy dark-green leaves. One peculiarity of the species is that the whole plant dies back to the root-stock after fruiting.

B. parviflora Roxb. (*Spatholobus roxburghii* Benth.). Most forest officers of the present generation will know this creeper by its second name and recognize it as one of the largest climbers in the forests of India. The trunk attains a girth of 3 ft. or more and it can top the tallest trees. It is common all over India and Burma and does a great deal of damage in the moist deciduous forests. If the trunk be cut through, deep-red concentric bands of bast in the wood become visible. A ruby-red gum exudes from the cut surfaces. In fruit it is difficult to separate this climber from *B. superba*; in the latter, however, the calyx is broadly campanulate, in *B. parviflora*, narrowly campanulate. The lac-insect can be cultivated on this species.

15. *Spatholobus* Hassk. A genus of climbers. The best-known species, *S. roxburghii* Benth., is now considered to be a species of *Butea*.

16. *Erythrina* Linn. A genus of small and middle-sized trees. All of them have pretty red flowers and some are greatly prized in gardens.

The following are common species in India.

Trees:

- | | |
|--|-----------------------|
| Calyx oblique, spathaceous and splitting: | |
| Calyx split to the base; tip 5-toothed ... | <i>E. variegata</i> |
| Calyx split half way down; tip entire: | |
| Wings longer than calyx ... | <i>E. stricta</i> |
| Wings minute ... | <i>E. lithosperma</i> |
| Calyx not spathaceous but 2-lipped: | |
| Leaflets broadly ovate or rhomboid ... | <i>E. suberosa</i> |
| Leaflets elliptic, much longer than broad | <i>E. fusca</i> |

Shrubs:

- | | |
|---|-----------------------|
| Flowers from a perennial root-stock ... | <i>E. resupinata</i> |
| Flowers from the branches ... | <i>E. arborescens</i> |

E. variegata Linn. (*E. indica* Lamk.). The Coral tree. A moderate-sized tree of rapid growth with young shoots covered

with stellate pubescence and with black prickles on the branches. Bark smooth, yellowish or greenish-grey, exfoliating in papery flakes. Petioles without prickles. This is usually described as a littoral tree but it is often found inland where it is planted. It may be wild in Assam. It grows easily from cuttings and is often used as a hedge-plant.

E. stricta Roxb. A large or moderate-sized tree found throughout India and Burma. The bark is very similar to that of the former but the prickles on the branches are yellow in colour while the petioles are also prickly.

E. lithosperma Miq. A middle-sized prickly deciduous tree common along streams in the hill savannah and upper mixed forests of Pegu and Tenasserim.

E. suberosa Roxb. A small tree with a thick, corky, deeply furrowed bark. Blaze thick, yellowish. Prickles usually light-yellow in colour. The bark yields a good cordage fibre.

E. fusca Lour. (*E. ovalifolia* Roxb.). A prickly tree reaching 100 ft., but usually much smaller. Planted in the tea-gardens of Assam as a shade-tree. It is said to be indigenous in lower Bengal and Burma. Flowers dark-crimson, almost purple.

E. resupinata Roxb. A remarkable shrub found in savannah land. The aerial shoots die down every year. The racemes are produced before the leaves from the root-stock and are bright-scarlet in colour.

E. arborescens Roxb. A small shrub with handsome foliage and flowers, extending from central India to Assam and perhaps to Burma.

17. *Flemingia* Roxb. A small genus with gland-dotted leaves and inflated pods, well represented in India. One species, *F. vestita* Benth., is cultivated in the Khasi Hills for its starchy tubers. *F. lineata* Roxb. has been tried as a green manure. *F. congesta* Roxb. is the source of the dye *Waras*. According to Burkill the portion of the plant from which the dye is obtained is the glandular hair on the outside of the pods. *F. strobilifera* R. Br. is a small tree of western India.

18. *Ougeinia* Benth. There is only one species of this genus in India, known as *O. dalbergioides* Benth. It is found generally over the whole of India except in the wetter parts. It is very common in the sal forests of Uttar Pradesh. It is a small to moderate-sized deciduous tree with a crooked stem. The bark is ashy-grey or light-brown and is covered with regular longitudinal and horizontal cracks exfoliating in regular flakes. The blaze is finely streaked with blood-red on a white ground, and exudes a red gum similar to kino. The timber is said to be proof against white ants and to be capable of taking a fine polish. The flowers, pink in colour, are produced in dense fascicles from the old wood, usually when the tree is leafless, at the beginning of the hot weather. It is often planted in

gardens as an ornamental tree. The bark is said to be toxic to fish. The young leaves are often lopped from the tree as fodder for cattle.

19. *Desmodium* Desv. A genus of herbs and shrubs with 1-3-pinnately compound leaves, very common in the undergrowth of our forests. They are easily recognized in fruit by the articulated pods, each segment being 1-seeded. Some have been used as green manure without much success.

Many exotic species of the *Papilionaceae* are cultivated in Indian gardens. The Gorse, *Ulex europaeus* Linn., and the Laburnum, *Cytisus laburnum* Linn., are cultivated in the hill-stations of the north-western Himalayas and in the Nilgiris. The Broom, *Cytisus scoparius* Link, is also cultivated in the Himalayas and Nilgiris. The Spanish Broom, *Spartium junceum* Linn., is grown in hills and plains in the Punjab. The Chinese *Wistaria sinensis* DC. is a common ornamental creeper which does very well in northern India.

Mucuna Adans. A genus of climbers of which several species are found in India. They are chiefly known for the spicular hairs which are found on the pods and stems of some species. The hairs cause intense irritation, which lasts for a long time, if they should fall upon the skin. It is not necessary to rub against the pods but, if the trunk of the creeper be shaken, the hairs fall and are sufficient to cause the irritation. The pain and irritation are said to disappear if the skin is heated at a fire. Should the hairs get into the intestine they cause haemorrhage, wasting and death and are sometimes used in this way by criminals.

M. prurita Hook. (*M. pruriens* DC.) is well known in Bengal, where it is a pest in sal plantations.

9. CUNONIALES

Trees or shrubs ; flowers hermaphrodite, actinomorphic ; carpels free or united ; stamens numerous to few ; embryo small ; endosperm copious.

15. HYDRANGEACEAE 16. ESCALLONIACEAE
17. CRYPTERONIACEAE 18. GROSSULARIACEAE

15. HYDRANGEACEAE

Shrubs or trees. Leaves opposite, exstipulate, glabrous or hairy, the hairs either simple, stellate or lepidote-glandular (Hutchinson). Inflorescence of panicles or corymbose cymes, with occasionally the marginal flowers sterile with enlarged sepals. Calyx-tube adnate, with 4-10 perigynous lobes. Petals 4-10, valvate, imbricate or contorted in the bud. Stamens 5-many, perigynous ; filaments free or slightly connate at the base.

Ovary mostly inferior or semi-inferior; of 2-5 united carpels, each with its separate style or the styles connate; ovules numerous or few, anatropous. Fruit a capsule. Seeds small with copious endosperm and a small embryo.

Key to the species of *Hydrangeaceae*

Leaves opposite:		
Trees or climbing shrubs	...	<i>Hydrangea</i>
Erect shrubs:		
Flowers white:		
Stamens 10; hairs stellate	...	<i>Deutzia</i>
Stamens 2-40; hairs simple	...	<i>Philadelphus</i>
Flowers blue:	...	<i>Dichroa</i>
Leaves alternate:		
Leaves 1-nerved; fruit a capsule	...	<i>Itea</i>
Leaves 3-5-nerved; fruit a berry	...	<i>Ribes</i>

The first three would go into *Hydrangeaceae*, *Itea* into *Escalloniaceae* and *Ribes* into *Grossulariaceae* as defined by Hutchinson.

Hydrangea Linn. A small genus of shrubs and trees often climbing by means of adventitious roots. Everyone knows the garden plant, *H. hortensis* Sieb., a native of China, which is universally admired for its beautiful blue flowers. In most of the hill-stations of India, however, the flowers, instead of being a clear blue, are a dirty white or even pink. It is usually recommended that some crystals of an aluminium salt be added to the soil to remedy this and restore the blue colour to the flowers. The flowers of the various species are of interest because they are dimorphous, the outer being sterile and very much larger than the inner fertile flowers. In fact, it is the sterile outer flowers which give the beauty to the trichotomous corymbose cymes of *Hydrangea*. *H. altissima* Wall. is a large deciduous scandent shrub found in the Himalayas from the Ravi eastwards in moist, shady places from 4,000-8,000 ft. The outer bark is brown, shining, peeling off in thin papery rolls which can be used as paper. *H. robusta* Hook. f., found in Sikkim and eastwards, is a middle-sized tree which is very common as an underwood in the hill-forests. The fertile flowers in this species are bright-blue but the sterile flowers are a faded pink or dirty-white.

Deutzia Thunb. A small genus of deciduous shrubs usually clothed with unicellular stellate hairs. There are two common species in the hilly tracts of India.

Petals imbricate; bark peeling off in papery rolls; leaves green beneath	...	<i>D. corymbosa</i>
Petals induplicate-valvate; bark peeling in thin longitudinal strips; leaves grey beneath	...	<i>D. staminea</i>

The former species lives in shady ravines in the hills from Kashmir to Bhutan, the latter is often found on sunny hill-sides which the former species avoids. The flowers are handsome.

Philadelphus Linn. *P. tomentosus* Wall. (*P. coronarius* Linn. var. *tomentosus*) is a deciduous shrub found in the hills, 5,000-9,000 ft. from Kashmir eastwards to Bhutan. It is apt to be mistaken for *Deutzia corymbosa*, but is readily distinguished by its simple hairs, those of *Deutzia* being stellate.

Dichroa Lour. *D. febrifuga* Lour., the only species, is a large shrub found in the evergreen hill-forests of the Himalayas from Nepal eastwards, extending to the Naga and Khasi Hills and into Burma. The flowers are blue but the bright-blue fruits are more striking. The Nepalese use a decoction of the shoots and bark of the roots as a febrifuge.

Itea Linn. A small genus of evergreen shrubs with characteristic biconical capsules arranged in a raceme.

16. ESCALLONIACEAE

Trees or shrubs. Leaves simple, alternate, serrate with gland-tipped teeth; stipules present. Inflorescence most often a raceme. Flowers hermaphrodite, rarely dioecious or polygamous, actinomorphic. Calyx of sepals usually united below, rarely free, imbricate or valvate, often persistent. Petals free or rarely connate into a short tube, valvate or imbricate. Stamens five, rarely four or six, perigynous, free, sometimes alternating with staminodes; anthers 2-locular, opening by slits. Ovary syncarpous or rarely apocarpous, 1-6-locular; ovules numerous, central in 2-6-locular ovaries, parietal in 1-locular ovaries. Fruit a capsule or berry. Seeds with copious endosperm and small embryo. The species of this family comprise some common garden-plants. *Brexia madagascariensis* Thouars, which grows in Madagascar, is sometimes planted in India. It has waxy handsome white flowers and coriaceous thick leaves. *Itea* Linn., a small genus of evergreen shrubs, is found in the hills. The fruit is exactly like two cones placed base to base.

17. CRYPTERONIACEAE

Deciduous trees with 4-angled branches. Leaves opposite, glabrous, elliptic, narrowed at the base, exstipulate. Inflorescence of cylindrical, spiciform, paniced racemes. Flowers small, yellowish-green, numerous, actinomorphic, polygamo-dioecious. Calyx-tube inferior, 4-5-lobed; lobes valvate. Petals absent. Stamens 4-5, alternate with the calyx-lobes; anthers 2-locular, didymous; disk absent. Ovary superior, 2-locular; style slender; ovules numerous on axile placentas. Fruit a capsule, 2-valved, loculicidally dehiscent. Seeds minute, without endosperm.

Crypteronia paniculata Bl. is the only species of this family in India, and it is confined to the Andamans. It is a moderate-sized tree with angled branchlets. The bark is brown, exfoliating in thin irregular flakes; blaze light-brown, watery. The timber is not of any particular value, but according to Burkill it is hard and durable, and is used for house-building wherever it occurs. The young leaves of this tree are deep-blue in colour.

18. GROSSULARIACEAE

Woody shrubs, often armed with spines. Leaves simple, alternate or fasciculate, plicate or convolute in the bud, stipulate or exstipulate. Inflorescence racemose or of solitary flowers. Flowers hermaphrodite, often unisexual by abortion. Calyx-tube adnate to the ovary with imbricate or subvalvate lobes. Petals 4-5, mostly small or scale-like. Stamens equal in number to the petals and alternate with them; anthers 2-locular, didymous or subglobose, opening by slits. Ovary inferior, 1-locular with two parietal placentas; ovules numerous or few, 2- or more-seriate. Fruit a berry. Seeds with endosperm and a small embryo.

The genus *Ribes* Linn. is common.

Ribes Linn. There are five species of this genus in the Himalayas which can be separated by the following key (after Parker).

- | | | |
|--|-----|---------------------|
| Prickly, flowers solitary or clustered | ... | <i>R. alpestre</i> |
| Unarmed, flowers racemose: | | |
| Calyx-limb short, spreading: | | |
| Sticky-glandular; lobes of the leaves obtuse | | <i>R. orientale</i> |
| Nearly glabrous; lobes of the leaves acute | | <i>R. glaciale</i> |
| Calyx-limb campanulate or tubular: | | |
| Leaves with yellow glands beneath | ... | <i>R. nigrum</i> |
| Leaves without yellow glands | ... | <i>R. rubrum</i> |

R. alpestre Dcne. The Gooseberry of Lahul. This prickly shrub is found in the inner valleys of the Punjab Himalayas. The fruit is like the cultivated gooseberry, but it is black in colour, very sour and is not edible.

The other species are not of much importance except that they are alternate hosts of some of the Himalayan coniferous rusts.

10. ARALIALES

Trees or shrubs; flowers hermaphrodite or dioecious, actinomorphic; sepals connate; petals valvate or imbricate; ovary inferior; embryo often small; endosperm copious.

19. CORNACEAE 20. ALANGIACEAE
21. ARALIACEAE

19. CORNACEAE

Trees or shrubs. Leaves alternate or opposite, petiolate, entire or angular-lobed or serrate, exstipulate, or stipules present (*Helwingia*). Inflorescence of dichotomously branched cymes, umbels or heads. Flowers hermaphrodite or dioecious, actinomorphic, white or yellow or sometimes green or lurid. Calyx-tube adnate to the ovary, subtruncate or 4-5-lobed. Petals 4-5, rarely absent, alternate with the calyx-lobes, imbricate or valvate. Stamens equal in number to and alternate with them; filaments short; anthers 2-locular, introrse, opening by longitudinal slits. Disk present, cushion-shaped, fleshy, central in the male flower, epigynous in the female flower. Ovary inferior, 1-4-locular; ovules solitary in each loculus, pendulous; style simple or lobed. Fruit a drupe or berry, 1-4-locular, with 1-4 bony or crustaceous pyrenes. Seeds oblong, terete, with copious endosperm.

The following is a key to the genera.

Flowers on the midrib of a leaf	...	1. <i>Helwingia</i>
Flowers not on the midrib of a leaf:		
Flowers hermaphrodite:		
Ovary 2-locular	...	2. <i>Cornus</i>
Ovary 1-locular	...	3. <i>Mastixia</i>
Flowers unisexual:		
Leaves opposite	..	4. <i>Aucuba</i>
Leaves alternate	...	5. <i>Nyssa</i>

1. *Helwingia* Willd. is represented by one species, *H. himalaica* Hook. f. et Thoms., which grows between 7,000 and 9,000 ft. in the hills of the eastern Himalayas and also in Manipur and in China. It is a small evergreen shrub, of no importance to forestry, but of botanical interest because of the fact that the unisexual flowers are found in umbels on the midribs of the leaves. This is one of the very few instances known of epiphyllous inflorescences. The leaves bearing the inflorescence in the Indian species are in no way different from the other leaves but in other species it sometimes happens that the leaf-blade is reduced and is often only wing-like in character. The inflorescence is umbellate, but study has shown (according to Wangerin) that the branching is really cymose and dichasial. Wangerin, who monographed *Cornaceae* in *Das Pflanzenreich*, endorses Payer's finding in respect of the true origin of this epiphyllous inflorescence. According to Payer the inflorescence is originally completely free from the leaf-blade and develops from a bud in the axil of the leaf. Subsequently, owing to intercalary growth at the leaf-base, the flower-bud is carried up until

it finally rests upon the middle of the leaf-blade. This theory is borne out by Wangerin's discovery that the inflorescence has a vascular bundle which is quite distinct from that of the midrib of the leaf.

2. *Cornus* Linn. is a small genus represented by three species in India.

Flowers in branched cymes:

Fruit globose; leaves 2-3 in. broad ... *C. controversa*

Fruit ovoid; leaves 1-1.5 in. broad ... *C. oblonga*

Flowers in globose heads, surrounded by four large yellow petaloid bracts ... *C. capitata*

The species of this genus are found only in the Himalayas and the mountains between Assam and Burma. *C. controversa* Hemsl. (*C. macrophylla* Wall.) is common in Chakrata and the hills of Tehri-Garhwal.

C. capitata Wall.¹ is easily recognized by the petaloid bracts below the inflorescence and fruit. This tree is cultivated in the Himalayas, where it is known as the Strawberry tree, for ornament and also for its fruit which can be made into preserves.

3. *Mastixia* Bl. is a genus of evergreen trees. There are three species in India.

Bracts leafy, up to 0.75 in. long:

Bracteoles conspicuous, linear ... *M. meiziana*

Bracteoles inconspicuous, lanceolate-acuminate ... *M. pentandra*

Bracts hardly any ... *M. arborea*

These trees are easily recognized by the fruit, which is an ovoid or ellipsoid drupe, crowned by the scars of the calyx-lobes. If the flesh be stripped off the stone, a deep longitudinal groove will be found on the putamen. The leaves, too, when dry have a characteristic colour. *M. pentandra* Bl. dries olive-green, *M. arborea* C. B. Cl. bluish, and *M. meiziana* Wang. grey. These species are all large evergreen trees found in the climax forests of eastern and western India.

4. *Aucuba* Thunb. *A. himalaica* Hook. f. is a small evergreen tree of the eastern Himalayas growing at about 8,000 ft. It is easily recognized by its lurid-purple tetramerous flowers, arranged in fulvous hairy panicles. The drupe is scarlet or orange.

5. *Nyssa* Linn. There are three species of this genus in India and Burma.

Key to the species (after Parker)

Leaves green beneath, not papillose; style undivided

N. javanica

¹ Now known as *Dendrobenthamia capitata* (Wall.) Hutch.

Leaves more or less grey beneath, distinctly papillose under the microscope; style bifid:

Leaves more or less hairy on the nerves beneath; lateral nerves 12-17 pairs; drupe 0.5 in. long *N. bifida*

Leaves glabrous except sometimes in nerve axils beneath; lateral nerves 8-10 pairs; drupe 1.8 in. long

N. megacarpa

These three species are tall evergreen trees found in the climax forests of Bengal, Assam and Burma. *N. javanica* (Bl.) Wang. (*N. sessiliflora* Hook. f.) is found in all three habitats, *N. bifida* Craib in Assam and Burma and *N. megacarpa* Parker is confined to Burma. They can be easily recognized in flower by the globose heads which contain many male flowers and a few female. Wangerin has proposed a family, *Nyssaceae*, to contain this genus and two others. *Nyssaceae* differs from *Cornaceae* principally in the capitate inflorescence not being supported by petaloid bracts.

20. ALANGIACEAE

Trees or shrubs, armed or not. Leaves alternate, petiolate, entire or lobed, usually unequal at the base, penninerved, or palmately nerved from the base, exstipulate. Inflorescence of axillary fascicles, cymes or corymbs. Flowers hermaphrodite, actinomorphic, white or yellowish-white, articulate on the pedicels; bracts absent, or small and deciduous. Calyx-tube adnate to the ovary, truncate at the top, or 4-10-toothed. Petals 4-10 in number, linear strap-shaped, valvate, at length recurved. Stamens equal in number to the petals and alternate with them or 2-4 times as many; filaments free or slightly connate at the base, more or less villous inside; anthers elongate, linear, 2-locular, opening by longitudinal slits. Disk present, cushion-like, surmounting the ovary. Ovary inferior, turbinate, 1-2-locular; ovule solitary, pendulous; style simple; stigma large, capitate. Fruit a 1-seeded drupe, crowned by the calyx-lobes and disk. Seeds with copious endosperm.

The family was included under *Cornaceae* by Bentham and Hooker, but has correctly been separated as distinct in *Das Pflanzenreich*. The genus *Alangium* Lam. is found in India.

The following is a key to the two common species.

Flowers in fascicles; stamens 2-4 times as many as the petals *A. salviifolium*

Flowers in cymes; stamens as many as the petals *A. chinense*

A. salviifolium Wang. (*A. lamarckii* Thw.) is a large deciduous spiny shrub or small tree widespread in India from the

sub-Himalayan tract to the Western Ghats of Bombay State and Madras State. The bark is orange-yellow when young, grey when old. This species is apt to be mistaken for a species of *Grewia* in the field from the shape of the flower-heads, flowers with recurved petals and leaves 3-nerved from the base. The two can be easily separated by remembering that in *Grewia* the sepals are longer than the petals, and that these are never more than five in number, and that also they possess a thick basal claw and the flowers are in cymes. None of these features are present in the species of *Alangium*. The wood, though never obtainable in large pieces, is said to be used for pestles, rollers, etc. The bark, both root and stem, has enjoyed a great reputation in Indian medicine from very early times.

A. chinense (Lour.) Merr. (*A. begoniifolium* Baill., *Marlea begoniifolia* Roxb.) is a small tree with smooth grey bark and characteristic angular-lobed leaves and cymes of white flowers. It is common in the sub-Himalayan tract extending into Burma, and found in the hills up to an altitude of 6,000 ft. The wood is of no importance.

Key to all the species of *Alangium* in India and Burma

Stamens 2-4 times as many as the petals:

Stamens 14; flowers 0.3 in. long, 7-merous ... *A. kingianum*

Stamens 20-30; flowers 2-3 in. long, 6-10-merous

A. salviifolium

Stamens equal in number to the petals:

Stigma simple, not lobed:

Style somewhat clavate towards the apex; leaves coriaceous:

Calyx-limb definitely toothed ... *A. nobile*

Calyx-limb with minute teeth ... *A. ebenaceum*

Style cylindrical; leaves membranous or thinly coriaceous

A. barbatum

Stigma 2- or rarely 3-lobed

... *A. chinense*

Distribution

A. kingianum Prain:

Kachin Hills

A. salviifolium Wang.:

India (principally west) and
Burma

A. nobile (C.B.Cl.) Harms.:

Burma

A. ebenaceum Griff.:

Burma

A. barbatum (R. Br.) Baill.:

Assam, Chittagong

A. chinense (Lour.) Merr.:

Eastern India

21. ARALIACEAE

Trees or shrubs, rarely herbs, sometimes climbing by means of aerial roots, sometimes epiphytic. Leaves alternate, very rarely opposite, simple, pinnate or digitate; petioles enlarged and

thickened at the base; stipules either adnate to or scarcely distinguishable from the base of the petiole, rarely absent. Inflorescence umbellate, rarely racemose or capitate. Flowers hermaphrodite, polygamous or dioecious, actinomorphic. Calyx superior, small, entire or toothed, usually inconspicuous; teeth or lobes often five. Petals three or more, often five, valvate or slightly imbricate, free or united at the top and falling off like an operculum (*Tupidanthus*). Stamens as many as the petals and alternate with them, or very many; anthers 2-locular, opening by longitudinal slits. Disk present, situated on top of the ovary. Ovary inferior, 1- or more-locular; ovules solitary in each loculus; styles free or connate; stigmas simple. Fruit a berry or drupe. Seeds with copious endosperm; embryo small.

This family is of little importance in forestry, but a number of species are harmful and common climbers and the others are frequently found as undershrubs or trees in evergreen forests, especially in the temperate areas. The family is closely related to *Umbelliferae*, the main difference between the two being that in *Araliaceae* the fruit is a drupe or berry, while in *Umbelliferae* the fruit is of two cocci which have oil-canals (vittae) in the pericarp.

Schefflera venulosa Harms. (*Heptapleurum venulosum* Seem.) is a well-known climber which is exceedingly common in northern India, Assam, Bengal, Burma and other areas. The Ivy, *Hedera nepalensis* K. Koch. (*H. helix* auct. non Linn.) is a large woody climber which clings to trees, rocks or walls by numerous fine rootlets. It is a temperate species and is not found below 2,000 ft. in the Himalayas.

Tupidanthus calyptratus Hook. f. et Thom. is a most remarkable small tree found in the Khasi Hills, which sometimes grows into a gigantic climber. It is remarkable in the family for the calyx-lobes and petals being connate into a calyptrum which falls and exposes the stamens. The latter are also unusually numerous in this genus, being up to one hundred in number. The glossy digitate leaves and stout umbellate inflorescence together could scarcely be mistaken for any other species.

11. STYRACALES

Trees or shrubs; flowers hermaphrodite; ovary superior to inferior; stamens few and alternate with the corolla-lobes or more numerous; embryo straight or curved; endosperm copious.

22. STYRACACEAE 23. SYMPLOCACEAE

22. STYRACACEAE

Trees or shrubs, often with stellate tomentum. Leaves alternate, simple, exstipulate. Inflorescence of axillary or terminal

racemes. Flowers hermaphrodite, actinomorphic, handsome. Calyx-tube more or less adnate to the ovary, truncate or 4-5-toothed; lobes or teeth valvate or open. Corolla with a short tube and imbricate or valvate petals on the hypanthium, 5-lobed. Stamens ten, inserted in the corolla-tube; filaments short, mostly connate at their broadened bases; anthers 2-locular, opening by longitudinal slits. Ovary nearly free or inferior, 3-locular below, 1-locular above; ovules few in each loculus. Style subulate; stigma capitate. Fruit drupaceous or capsular, breaking up irregularly, or 3-valved, 1- rarely 2-seeded. Seeds with copious endosperm; embryo straight, axile or eccentric with broad cotyledons.

There are two genera of this family in India, *Styrax* and *Parastyrax*, the latter differing from the former in the possession of a fruit and ovary which are wholly inferior. *Parastyrax lacei* W. W. Smith is the only species in *Parastyrax*. It is an enormous tree of 150 ft. or over, and is found on Kadu Hill in the Katha District, Burma, and also on the north-east frontier of Assam.

Styrax Linn. is represented by several species and the following is a key to the more common ones.

Under-surface of leaves white-tomentose *S. rugosum*

Under-surface of leaves not white-tomentose:

Flowers small; calyx capsular in fruit; small tree or shrub *S. serrulatum*

Flowers large; calyx cleft in fruit; moderate-sized tree

S. hookeri

S. rugosum Kurz is an evergreen shrub or small tree, all parts covered with a floccose tomentum, that on the lower surface of the leaves being white in colour. This species is only found in Burma.

S. serrulatum Roxb. is a shrub or small tree very common in Bengal, Assam and Burma from the plains up to 5,000 ft. The leaf-buds often grow out into softly hairy galls up to 5 in. long; it is unusual to find a plant without the galls. This tree yields an inferior kind of benzoin.

S. hookeri C. B. Cl. A moderate-sized tree found in the eastern Himalayas at an altitude of 6,000-7,000 ft. The tree is very handsome when in flower.

Benzoin is yielded by *S. benzoin* Dryand., a fairly tall tree found in Sumatra, Java, etc.

23. SYMPLOCACEAE

Trees or shrubs. Leaves alternate, simple, sessile or shortly petioled, exstipulate, often turning yellow when dry. Inflorescence of solitary axillary or terminal flowers, or of simple or compound racemes or panicles. Flowers hermaphrodite, actino-

morphic; bracts usually solitary at the base of each pedicel; bracteoles 1-3, both usually early caducous. Calyx-tube adnate to the ovary, 5-lobed; lobes imbricate. Petals five in one series, or more in two series, white or yellow, usually free or shortly connate at the base, sometimes connate in a tube, imbricate. Stamens usually numerous, many-seriate, adnate to the corolla-tube or the petals, most usually in groups; filaments filiform or flattened; anthers 2-locular, short, dehiscing by longitudinal slits. Ovary inferior, usually 3-, rarely 2- or 4-locular; ovules 2-4 in each loculus, pendulous from the inner angle; style filiform; stigma capitate or slightly lobed. Fruit a cylindric or sub-globose drupe, crowned by the calyx-lobes; stone usually woody, 1-seeded. Seeds oblong; testa thin; endosperm fleshy; embryo straight or curved; cotyledons short.

This family was included by Benthams and Hooker in *Styracaceae*, but has been separated from that family, chiefly on account of the inferior, completely septate ovary, which develops into a drupaceous fruit crowned by the persistent calyx-teeth. The family contains only one genus, *Symplocos* Jacq., of which a large number of species is found in India. The genus is very easy to spot in the forest from its leaves alone which dry to a yellowish-green colour. Students sometimes confuse this family with *Rosaceae* on account of the similarity in the structure of the flowers. They can, however, be easily separated. *Rosaceae* has stipulate leaves while the leaves of *Symplocaceae* are exstipulate. The species are, for the most part, small trees but one or two reach timber size. *S. reticulata* Grah. (*S. beddomei* C. B. Cl.), for instance, is a very large tree found in the evergreen climax forests of the Indian Peninsula. It is thought that this wood may prove useful for match-splints. *S. spicata* Roxb., the only species with a globose fruit, also grows into a large tree.

12. HAMAMELIDALES

Trees or shrubs ; flowers hermaphrodite, actinomorphic, often collected into heads ; ovary often bicarpellary, inferior ; stamens perigynous ; stamens 4-8 or more ; embryo straight ; endosperm scanty.

24. HAMAMELIDACEAE 25. PLATANACEAE
26. BUXACEAE

24. HAMAMELIDACEAE

Trees or shrubs, often with stellate indumentum. Leaves alternate, petioled, simple, penninerved, deciduous or evergreen, stipulate; stipules paired, sometimes large and fleshy. Inflorescence of dense heads or catkin-like spikes. Flowers actinomor-

phic or zygomorphic, hermaphrodite or unisexual. Calyx-tube 4-5-lobed, more or less adnate to the ovary; lobes imbricate or valvate. Petals four or more, rarely none (*Parrotia*), perigynous or epigynous, imbricate or valvate, alternate with the calyx-lobes, deciduous. Stamens four or more, perigynous, 1-seriate; filaments free; anthers 2-locular, opening by longitudinal slits or by valves. Disk absent, or, if present, of separate glands between stamens and ovary. Ovary semi-inferior, 2-locular; ovules one or more in each loculus, pendulous from axile placentas; styles two, usually persistent, finally divaricate. Fruit a woody capsule. Seeds one in each loculus, or numerous, in which case the lowest only is fertile; embryo straight, endosperm thin.

A family with few genera in India, being found mainly in North America, South Africa, Asia and Madagascar. *Hamamelis virginiana*, the Witch Hazel, is often cultivated in Europe.

Key to the genera of *Hamamelidaceae*

Ovules solitary in each loculus:

Petals 0 ... *Parrotia*

Petals 4-5 ... *Corylopsis*

Ovules several in each loculus:

Leaves entire; stipules coriaceous ... *Bucklandia*

Leaves serrate; stipules deciduous ... *Altingia*

Parrotia C. A. Mey. There is one species in India, *P. jacquemontiana* Dcne., which is confined to the north-west Himalayas, 3,500-8,500 ft. It is a large, deciduous, gregarious shrub, bearing a striking resemblance to the European Hazel. It is usually found in deodar forests and is of importance owing to its influence on the reproduction of that species. On the whole its influence on deodar recruitment is not favourable; deodar seedlings come up sparingly under its shade but have much difficulty in piercing the cover, so that regeneration is deficient in forests in which *Parrotia* is common.

Corylopsis Sieb. et Zucc. *C. himalayana* Griff. is a striking shrub found in the eastern Himalayas and exceedingly common in the Khasi Hills, especially in the marshy ground below Shillong Peak. This shrub is also very similar to the English Hazel in appearance. The flowers are distinctive, being yellow in colour and scented, arranged in densely silky, catkin-like spikes.

Bucklandia R. Br. *B. populnea* R. Br. is very easily spotted in the forest. The bark of poles is rough and black, that of old trees reddish-brown and deeply furrowed. The crown is dense and spreading and the leaves are cordate, shining and coriaceous. Moreover, the stipules are fleshy, oblong-obtuse in shape, paired over the apical bud. The tree is confined to the

eastern Himalayas, Naga and Khasi Hills. It is one of the best trees for afforestation in the Darjeeling hills and has been extensively used for the protection of hill-slopes liable to erosion.

Altingia Noronha. *A. excelsa* Noronha is a very tall (up to 100 ft.) aromatic deciduous tree found in the plains of Upper Assam and also in Burma. Fruits characteristic, being rough, woody, globose, 0.5 in. in diameter, of numerous velvety capsules almost immersed in the confluent calyces. The bark contains a clear resinous substance which is called Burmese Storax.

25. PLATANACEAE

Tree with the bark exfoliating in flakes. Leaves alternate, deciduous, palmately lobed, stipulate; stipules large, membranous, deciduous. Flowers monoecious in unisexual, usually sessile, globose heads; male and female heads sometimes on the same peduncle. Sepals 3-6; petals as many. Male flower; stamens as many as the sepals, each consisting of a large almost sessile anther, the two loculi parallel, adnate to a cuneate connective with a truncate top. Female flower; ovaries as many as the sepals, hairy at the base, surrounded by staminodes, 1-locular; ovule one, pendulous, orthotropous. Fruiting head consisting of numerous 1-seeded achenes. Seeds with scanty endosperm.

The well-known Chinara, *Platanus orientalis* Linn., belongs to this family. A large deciduous tree, the Chinara grows in south-east Europe and as far east as the Indus. It is planted in the Punjab rather frequently, and in Kashmir will be found growing at elevations up to 8,500 ft. The wood is white, tinged with yellow or red, with numerous broad medullary rays (Parker). It can easily be propagated by cuttings. The lobed leaves, the bark peeling off in large flakes, and the pendulous fruit, consisting of a head of 1-seeded achenes, make this tree easy to identify.

26. BUXACEAE

Trees or shrubs. Leaves evergreen, alternate or opposite, simple, coriaceous, exstipulate. Inflorescence cymose or racemose. Flowers bracteate, actinomorphic, monoecious or dioecious, sometimes a few hermaphrodite. Sepals imbricate or absent, usually four in number. Petals absent. Stamens four or six; when four—opposite the sepals, when six—two pairs opposite the inner sepals; anthers large, sessile or borne on long filaments, 2-locular, opening longitudinally by slits; rudimentary ovary present or absent in the male flowers. Ovary superior, 3-locular; ovules 1-2, pendulous, anatropous. Fruit capsular or drupaceous. Seeds black, glossy; endosperm copious; embryo straight.

Buxus Linn. There are two species of this genus in India. Both these species are principally found in the north-west Himalayas, occasionally in Bhutan.

Leaves shining above, pale-green beneath ... *B. wallichiana*

Leaves dull above, pale and whitish (papillose) beneath

B. papillosa

B. wallichiana Baill. is an evergreen shrub or small tree with opposite coriaceous shining leaves. The bark is soft, corky, yellowish-grey in colour, divided on old stems into numerous small rectangular plates, by horizontal and vertical fissures. This species extends from Bhutan to the north-west Himalayas between 4,000 and 9,000 ft. elevation. It occasionally forms pure stands but these are not of any great extent. The wood of *Buxus* is greatly valued and is sold as Box in the trade.

B. papillosa C. K. Schn. is a large evergreen shrub or small tree with a crooked stem found in dry situations below 4,000 ft. in the Himalayas.

13. SALICALES

Trees or shrubs ; flowers dioecious, in erect or pendulous catkins ; ovary 1-locular ; ovules numerous ; stamens two or more ; embryo straight ; endosperm absent.

27. SALICACEAE

Trees or shrubs with perulate buds. Leaves alternate, simple, deciduous, stipulate; stipules sometimes foliaceous and persistent. Inflorescence dioecious, male and female in pendulous or erect catkins. Flowers unisexual, dioecious. Male flower solitary in the axil of a membranous, fugaceous or persistent bract; perianth absent. Disk present as a small cupular disk or two glandular scales; stamens two or more; filaments slender, free or more or less united; anthers 2-locular, opening by longitudinal slits; rudimentary ovary absent. Female flower; ovary 1-locular, sessile or shortly stipulate, with 2-4 parietal placentas; ovules few to many, anatropous; stigma notched or lobed. Fruit an ovoid or lanceolate 2-4-valved capsule. Seed minute, enveloped in a mass of silky hair attached to the funicle, without endosperm; embryo straight.

The two Indian genera can be separated by the following key.

- | | | |
|---------------------------------------|-----|-------------------|
| Disk of 1-2 glands; petiole short | ... | 1. <i>Salix</i> |
| Disk flat or cup-shaped; petiole long | ... | 2. <i>Populus</i> |

1. The genus *Salix* is well represented in India. The species are very difficult of discrimination owing to the variation in

foliage, flowers and habit within a species. Moreover there is a marked tendency to hybridization and in addition the correlation of the sexes is a matter of some difficulty, especially in those species that flower before coming into leaf. The character of free or united stamens which is used in some works to separate sections cannot always be depended upon. The species fall naturally into two groups; those which are found in the north-west Himalayas and those found in the eastern Himalayas. R. N. Parker gives¹ a good key to the species found in the north-western Himalayas and it is reproduced below.

Stamens 3-12:

Leaves lanceolate or ovate-lanceolate, very pale beneath

S. tetrasperma

Leaves linear-lanceolate, usually entire ... *S. acmophylla*

Stamens 2; filaments free:

Dwarf shrubs of alpine situations; leaves not more than 1 in. long:

Rhachis of male catkins hairy:

Petiole less than 0.1 in. long ... *S. furcata*

Petiole 0.2-0.3 in. long ... *S. flabellaris*

Rhachis of male catkins glabrous ... *S. lindleyana*

Small or large shrubs or small trees; leaves over 1 in. long:

Leaves linear-lanceolate with revolute margins, silvery-silky beneath ... *S. viminalis*

Leaves broader, normally not silky:

Male catkins on short leafy shoots *S. denticulata*

Male catkins sessile or with a few leaves at the base:

A small shrub 3-5 ft. high ... *S. hastata*

Larger shrubs or trees:

Twigs glabrous or nearly so; leaves mostly rather coarsely serrate ... *S. daphnoides*

Twigs more or less tomentose; leaves entire or serrulate, often silky ... *S. wallichiana*

Key to the species of the eastern Himalayas

Stamens 3-12 ... *S. tetrasperma*

Stamens 2:

Trees or large shrubs:

Catkins on leafy peduncles:

Capsules stipitate ... *S. hastata*

Capsules sessile:

Branchlets black, glabrous ... *S. daltoniana*

Branchlets not black and glabrous:

Female catkins very slender, 2-5 in. long; bracts minute ... *S. longiflora*

¹ In *A Forest Flora for the Punjab with Hazara and Delhi*.

- Female catkins 1.5-2 in. long; bracts broadly ovate ... *S. eriostachya*
- Catkins sessile:
- Leaves densely silky beneath:
- Male catkins short, 1 in. long; under-surface of leaves green and silky ... *S. eriophylla*
- Male catkins slender, 1-2 in. long; under-surface of leaves coppery and silky ... *S. sikkimensis*
- Leaves not densely silky beneath ... *S. obscura*
- Small shrubs, prostrate:
- Leaves narrow; width less than one third the length:
- Leaves 0.25-0.5 in. long ... *S. serpyllum*
- Leaves over 0.5 in. long ... *S. thomsoniana*
- Leaves broader; width more than one third the length:
- Leaves very small, less than 0.25 in. long, deeply serrulate at the apex ... *S. oreophila*
- Leaves 0.3 in. or more, not serrulate ... *S. calyculata*

In addition to the species named above several European species have been introduced. Among them may be mentioned *S. babylonica*, *S. caprea*, *S. fragilis* and *S. alba*. These introduced species can be separated as follows (Parker).

- Leaves broadly elliptic or obovate ... *S. caprea*
- Leaves lanceolate:
- Branches drooping ... *S. babylonica*
- Branches not drooping:
- Young twigs silky-hairy ... *S. alba*
- Young twigs glabrous ... *S. fragilis*

The question of which willow is most suitable for cricket-bats is of importance owing to the demand for bats in India. It appears from an investigation carried out by Burt Davy (*Quart. Journ. For.*, 1932) that the wood which is most esteemed for cricket-bats in England is that furnished by the variety of *S. alba* Linn. known as *caerulea*. Burt Davy says that *Salix alba* Linn. and *S. fragilis* Linn. are often grown together in England in marshy places and hybridize freely. The hybrid between the two is known as *X S. viridis* (Fries). Numerous forms of the hybrid are met with and it is from these forms, especially those resembling *S. alba*, that cricket-bat timber is obtained. It is not clear, however, what the morphological differences are between *S. alba* and *S. alba* var. *caerulea*. The buyer of willow-wood selects preferably female trees only, with upright branching and a bark which is not deeply fissured. All male trees are rejected and also those with wide spreading branches and a deeply fissured bark. As the timber for cricket-bats does not mature until twenty years are past it is most important for growers in this country to see that the cuttings

put into their plantations are from the proper strain, otherwise their losses are likely to be heavy.

Willows are, as a rule, easily raised from cuttings put in wet places.

2. *Populus* Linn. There are eight species of this genus in India, all of which are found in the Himalayas, usually in temperate climates.

The following is a key to the species.

Leaves lobed ; buds dry :

Leaves glabrous ... *P. euphratica*

Leaves white-tomentose beneath ... *P. alba*

Leaves not lobed ; buds sticky :

Leaves orbicular ... *P. microcarpa*

Leaves not orbicular :

Leaves triangular or rhomboidal, almost as broad as long
P. nigra

Leaves ovate or ovate-lanceolate :

Leaves glabrous beneath ... *P. balsamifera*

Leaves more or less hairy, often on the margins or on the nerves at the base :

Capsules 3-valved ... *C. ciliata*

Capsules 2-valved :

Valves glabrous ... *P. gamblei*

Valves hairy ... *P. glauca*

P. euphratica Oliv. is a large tree with thick, irregularly furrowed, rough bark found in the plains of the Punjab and confined to the banks of rivers. The leaves of young plants and coppice shoots are linear while those on older trees are rhomboid or cordate and variously lobed. The tree is more or less gregarious and occurs in riverain tracts associated with *Acacia arabica* and species of *Tamarix*. Although this species is found in the plains of the Punjab it can ascend to very great heights and is actually found in Tibet at an altitude of 13,500 ft. The wood is of local use only.

P. alba Linn. is found wild but is also cultivated in the western Himalayas. It has been planted in the plains but does not do well there. The white under-surface and the lobed leaf distinguish this species from all the others. It can be propagated easily by means of cuttings.

P. microcarpa Hook. f. Little is known of this Bhutan tree.

P. nigra Linn. var. *pyramidalis* is a large tree with fastigate branches forming a narrow cylindrical crown. It is cultivated in north-west India but rarely flowers in this country.

P. balsamifera Linn. This large tree is extensively cultivated in north-west India, particularly in Kashmir. The long flexuose, yellowish-brown or grey branchlets and the sticky buds indicate this species.

P. ciliata Wall. This large deciduous tree is found all along the Himalayas as far east as the Subansiri river, 4,000-10,000 ft. Its tall clear bole is covered with a greyish, deeply fissured bark. Its associates are often oaks, sycamores, cherries and alders and it is usually found growing in the moister places in the hills but it can grow on dry hill-sides. The wood is said to be excellent for match-splints.

P. gamblei Dode and *P. glauca* Haines are both found in Sikkim and in the hill-forests of Bengal. The former with glabrous carpels is common in the Dumsong forests. The latter with hairy carpels, round leaves and red petiole and midrib is found on Tonghi, at Lachen and in Bhutan.

14. MYRICALES

Trees or shrubs; flowers dioecious or monoecious; sepals and petals absent or represented by bracteoles; ovary 1-locular, 1-ovuled; stamens 2-many; embryo straight; endosperm absent.

28. MYRICACEAE

Trees or shrubs, aromatic and glandular. Leaves alternate, simple, exstipulate. Inflorescence of flowers in dense-flowered bracteate catkin-like axillary spikes; spikes sometimes fascicled or paniced. Flowers unisexual, monoecious or dioecious, sometimes the sexes alternating on the same individual year by year; when the inflorescence is bisexual the male flowers are below the female. Male flowers often surrounded by two or more bracts, usually subtended by a solitary bract; stamens 2-16, usually four; filaments short, free or connate; anthers erect, 2-locular opening by longitudinal slits; rudimentary ovary rarely present. Female flowers 2-4-bracteate; ovary sessile, bicarpellary, 1-locular; ovule solitary in the loculus, erect; style 2-fid, the arms stigmatose on the inner side. Fruit a small ovoid or globose drupe, succulent, resinous or waxy, verrucose; endocarp hard. Seed erect; without endosperm, embryo straight.

There is one species of this family in India. *Myrica sapida* Wall. (*M. nagi* Thunb.) is a small or moderate-sized evergreen tree with a greyish-brown, rough, vertically fissured bark; blaze reddish-brown, fibrous, mottled with yellow streaks next the wood. This tree is found in the Naga and Khasi Hills and penetrates into Burma. The tubercled reddish drupes are very pleasant to eat and a refreshing drink can be made from them. The bark has medicinal virtues and is used to alleviate a number of complaints. The bark gives a very good yellow dye and can also be used to intoxicate fish.

15. FAGALES

Trees or shrubs; flowers monoecious in erect or pendulous catkins or the female in cones; ovary inferior, 2-6-locular; ovule 1-2 in each loculus; stamens 2 - many; embryo straight; endosperm absent.

29. BETULACEAE 30. CORYLACEAE 31. FAGACEAE

29. BETULACEAE

Trees or shrubs with perulate buds. Leaves alternate, usually penninerved, undivided, as a rule serrate, stipulate; stipules deciduous. Inflorescences monoecious, male in pendulous catkins; female in erect cone-like spikes. Flowers monoecious. Male flower seated in a scale within which are 2-5 bracteoles; perianth membranous, 4-partite; lobes slightly imbricate; stamens two or four; filaments very short; anthers 2-locular, opening by longitudinal slits; rudimentary ovary absent. Female flower without a perianth; ovule naked, compressed, 2-locular, with one pendulous ovule in each loculus; styles two, free, long, filiform. Fruiting spikes cylindric or ovoid; bracts deciduous or persistent. Fruit indehiscent, with one seed, naked or winged. Seed solitary, without endosperm; embryo straight.

Two genera are found in India and Burma.

Bracts of the fruiting spike forming a woody cone 1. *Alnus*
Bracts of the fruiting spike not forming a cone 2. *Betula*

1. *Alnus* Linn. The Alder. Two species of this genus are found in India.

The following key (after Parker) can be used to separate them.

Leaves narrowed from about the middle to the apex; lateral nerves or their branches running to the margin which is usually sinuately toothed; anther-loculi nearly distinct; female flower solitary, axillary; nut with a narrow coriaceous margin ... *A. nitida*

Leaves rounded, acute or abruptly very shortly acuminate; lateral nerves anastomosing within the margin which is usually entire; anther-loculi connate; female flowers in axillary racemes of 4-8; nut with a membranous wing

A. nepalensis

A. nitida Endl. is a large tree found in the north-west Himalayas but not extending to the east beyond the Jumna. The bark is dark-grey or brown, smooth, shining when young, very rough and furrowed on old stems. The young twigs are usually glabrous, covered with minute exudations of resin, a feature which also serves to distinguish it from the other species. The tree is common on river-banks and in moist places in the hill-valleys. The wood is reddish-white, soft and close-grained, but apparently it is not used.

A. nepalensis D. Don is a large deciduous tree found along the whole length of the Himalayas and extending into northern Burma. In the forest the bark has a dark-green colour but in the open it is generally silver-grey and resembles that of the birch. This tree has a very cylindrical stem and grows very rapidly. It is one of the first trees to appear on any landslips in the hills and on abandoned cultivation. This makes it a specially valuable tree in the hill-districts of Assam and Burma. In the Naga Hills, cuttings of the tree are planted in abandoned jhums in the Sema country, while in the Angami country the tree is pollarded and cultivated for fuel. The wood is greyish, soft, light and easily worked.

2. *Betula* Linn. The Birch. Three species of birch are found in India and they can be easily separated by the following key.

Bark pink or red, flaking off in vertical strips

B. cylindrostachys

Bark not pink or red but white or silvery:

Bark white; female spikes solitary; leaves tomentose below

B. utilis

Bark greyish-brown, silvery, papery; female spikes in clusters of 2-3; leaves glabrous ...

B. alnoides

B. cylindrostachys Wall. is a species found in the eastern Himalayas and in the Naga Hills, mostly below 6,000 ft. in Bengal, but higher in the Naga Hills. Doubts have been expressed whether this tree actually is distinct from *B. alnoides* or not. In the field they are absolutely distinct owing to the fact that the bark of *B. cylindrostachys* has a definite coppery tinge and peels off vertically in large flakes.

B. utilis Don (Syn. *B. bhojpattra* Wall.) is a moderate-sized deciduous tree with a somewhat irregular bole found all along the Himalayas. The bark is smooth and shining; white or pinkish-white with horizontal lines of lenticels, the outer bark consisting of numerous thin papery layers exfoliating in broad horizontal rolls; blaze moist, red. The thin layers of bark are used as paper. The wood is pinkish-white and is used locally for building.

B. alnoides Buch.-Ham. is a medium-sized deciduous tree with a dark-grey or brownish bark marked with long horizontal lenticels, peeling off in rather narrow horizontal bands. This species inhabits the Himalayas from end to end and extends into Assam, Manipur and Burma. The wood is only of local use.

30. CORYLACEAE

Shrubs or trees with buds protected by imbricating scales. Leaves alternate, prominently nerved, serrate, stipulate. In-

florescence monoecious; male in drooping, lateral, solitary or fascicled catkins; female in terminal or lateral, erect spikes. Flowers unisexual, monoecious. Male flower; stamens 3-6, inserted on a broad-ovate bract, supported or not by two bracteoles; perianth absent; filaments short, entire or bifurcating, with an anther-loculus on each arm; rudimentary ovary absent; anther-loculi opening by longitudinal slits. Female flower supported by an irregularly lobed perianth, seated in the axil of a bract; perianth adnate to the ovary; ovary inferior, rather imperfectly 2-locular; ovules two, or one by abortion, pendulous from the apex; styles two, free or nearly so, linear. Fruit a hard nut enclosed in the accrescent involucre. Seed solitary, without endosperm; embryo straight.

Two genera are found in India.

Fruit small, in drooping spikes, in the axil of large membranous reticulate bracts ... 1. *Carpinus*

Fruit a large nut enclosed in a thick, cut and lobed, sometimes spinescent, involucre ... 2. *Corylus*

1. *Carpinus* Linn. The Hornbeams. There are two Indian species.

Shoots and petioles glabrous; leaves glabrous except when very young ... *C. viminea*

Shoots and petioles tomentose; leaves silky on the nerves beneath ... *C. faginea*

C. viminea Lindl. is a medium-sized tree with an irregularly fluted stem. The bark is compact, grey with darker streaks. This tree is found in the north-western Himalayas and Khasi Hills between 5,000 and 7,000 ft. The wood is used only for fuel.

C. faginea Lindl. is a middle-sized tree with pubescent branches and dark-brown slightly wrinkled bark. This tree is found in the western Himalayas and apparently extends to China. It is not found in the eastern Himalayas.

2. *Corylus* Linn. The two species of this genus are easily distinguished from each other.

Involucre coriaceous, cleft into linear-lanceolate lobes with glandular hairs ... *C. colurna*

Involucre almost fleshy, thick; lobes pinnatifid; segments terminating in slender spines ... *C. ferox*

C. colurna Linn. is a small or medium-sized deciduous tree with dark-grey thin bark. This tree is found only in the north-west Himalayas between 5,000 and 10,000 ft. The wood is pinkish-white and fairly hard, but is used only locally. The nuts can be eaten.

C. ferox Wall. This very distinct tree is found in Sikkim between 8,000 and 10,000 ft. The ripe involucre is unmistakable.

31. FAGACEAE

Trees. Leaves alternate, simple but often deeply lobed, pinnerved, evergreen or deciduous, stipulate; stipules caducous. Inflorescence monoecious; male in drooping or erect catkin-like spikes; female in spikes. Flowers unisexual, monoecious. Male flower; perianth 4-6-lobed; lobes imbricate; stamens few to many (40); filaments free, filiform; anthers erect, 2-locular; loculi contiguous, opening by longitudinal slits; rudimentary ovary present or absent. Female flower seated in an adnate perianth, solitary within an involucre of often numerous imbricate scales; perianth adnate, 4-6-lobed; staminodes present or absent; ovary inferior, 3-6-locular; styles as many as the ovary loculi; ovules 2 in each loculus. Involucre in fruit often hardened, cupular or altogether closed, often tuberculate or echinate. Fruit a nut, free or adnate to the involucre. Seed solitary without endosperm.

This family, which comprises evergreen and deciduous trees, is found in all parts of the world. In India there are three genera which can be separated by the following key.

Ovary 3-locular:

Nuts supported by or enclosed in a cup which is not covered with spines ... 1. *Quercus*

Nuts enclosed in an enlarged involucre which is covered with spines ... 2. *Castanopsis*

Ovary 1-locular, involucre spinous ... 3. *Castanea*

1. *Quercus* Linn. The genus *Quercus*, or Oak, is on the whole a temperate genus and the majority of its many species are found in the temperate areas of India and Burma although, strangely enough, no species are found in the Nilgiris. A few species, however, among them *Q. lanceaefolia*, *Q. velutina* and *Q. semiserrata*, are often found in low-lying hot situations.

Important as the oak is in European forestry, the genus is not of very great importance in India although a number of species show a decided tendency to grow gregariously. The main use of the timber in India is as fuel though the wood of a number of species is prettily figured. An indirect value of oaks is, of course, the protection which they give to the economically more important coniferous trees, during the youth of the latter.

A key to the Indian and Burmese species follows. A glance at it will show that flowers and fruits as well as leaves are necessary for a correct determination.

- Male spikes lax, slender, pendulous:
 Involucre scaly; tips of scales free (*Lepidobalanus*):
 Acorns globular or subglobular:
 Cup small, covering only base of glans; leaves obtuse,
 entire or spiny-toothed ... *Q. semecarpifolia*
 Cup large, covering the whole glans except at the apex;
 leaves acute, setaceous-serrate ... *Q. serrata*
 Acorns not globular, elongate:
 Leaves entire or spinose on same tree:
 Leaves glabrous ... *Q. dilatata*
 Leaves stellate-tomentose below ... *Q. ilex*
 Leaves all serrate-toothed:
 Leaves obovate ... *Q. griffithii*
 Leaves oblong, not obovate:
 Tomentum rufous ... *Q. lanuginosa*
 Tomentum pale-grey ... *Q. incana*
 Involucres of concentric laminae or zones (*Cyclobalanopsis*):
 Nut ovoid or ovoid-cylindric:
 Leaves coriaceous:
 Nut 2 in. long; leaves green below, serrate-acuminate ... *Q. semiserrata*
 Nut less than 1 in. long; leaves glaucous below ... *Q. glauca*
 Leaves thinly chartaceous ... *Q. patkoiensis*
 Nut hemispheric or turbinate:
 Nut hemispheric:
 Apex of nut conical, not depressed ... *Q. brandisiana*
 Apex of nut more or less depressed:
 Leaves lanceolate, glaucous ... *Q. lineata*
 Leaves ovate-lanceolate or oblong, not glaucous ... *Q. mespilifolia*
 Nut turbinate:
 Nut only half enveloped by cupule:
 Leaves tomentose beneath ... *Q. helferiana*
 Leaves glabrous ... *Q. velutina*
 Nut more than half covered by a loosely lamellate cup ... *Q. lamellosa*
 Male spikes erect:
 Involucre completely enclosing the nut or apex free:
 Involucre not thick and woody (*Chlamydobalanus*), not adnate to nut except at base ... *Q. lanceaefolia*
 Involucre thick and woody; pericarp of nut osseous, more or less adhering to involucre (*Lithocarpus*):
 Involucre completely enclosing the nut:
 Fruits connate ... *Q. xylocarpa*
 Fruits not connate ... *Q. milroyi*
 Nut free from the involucre at the apex ... *Q. truncata*

Involucre not surrounding the nut completely; nut well exerted:

Involucres more or less saucer-shaped or discoid; apices of the imbricate bracts free (*Pasania*):

Nut conspicuously longer than broad:

Nut cylindric or cylindric-conic:

Leaves obovate to obovate-oblong

Q. lindleyana

Leaves oblong-lanceolate

Q. amherstiana

Nut ovoid:

Cup with bristly tubercles

Q. lappacea

Cup without bristly tubercles

Q. acuminata

Nut hemispheric, not conspicuously longer than broad:

Cupule covering almost the whole of the nut:

Cupules connate into a woody mass

Q. pachyphylla

Cupules partially connate or separate:

Leaves glabrous ...

Q. fenestrata

Leaves minutely tomentose beneath

Q. dealbata

Cupule covering only the lower portion of the nut:

Leaves lanceolate to oblanceolate

Q. spicata

Leaves ovate-lanceolate

Q. polystachya

Involucres cupulate; bracts connate into entire or denticulate lamellae:

Nut ovoid and longer than broad:

Leaves glabrous ...

Q. eumorpha

Leaves not glabrous ...

Q. lindleyana

Nut obovoid or turbinate ...

Q. thomsoni

Q. semecarpifolia Sm. This large evergreen tree is found in the Himalayas and in the Assam-Burma hills between 8,000 and 12,000 ft. It is typically gregarious in areas with a high snowfall and moderate rain, and avoids the inner valleys of the Himalayas where the rainfall is low. The bark contains much tannin. The acorns are solitary. The cup is small, flat and thin and covers only the extreme base of the globular smooth nut, which is nearly 1 in. in diameter.

Q. serrata Thunb. A moderate-sized or large deciduous tree found in the eastern Himalayas and the Assam-Burma hills between 3,000 and 8,000 ft. The Nagas plant the tree along the paths leading from the village to the cultivation. It is often seen in secondary hill-forest in the unadministered territory between Assam and Burma where it occurs with *Pinus insularis*, *Rhododendron arboreum*, *Alnus nepalensis* and *Quercus spicata*. This

rapidly growing tree has been found to be very suitable for hill-plantations. The wood can be used for building purposes. The acorns are solitary or in pairs, sessile or almost so. The cups are quite distinctive, having the scales much imbricate and almost free, 0.25 in. long, covering the whole of the young, and three-quarters of the ripe, nuts.

Q. dilatata Lindl.¹ A large evergreen tree found in the western Himalayas, chiefly between 7,000 and 9,000 ft. It avoids dry situations and favours those which are cooler and moister. The spinous holly-like leaves are very characteristic. The wood is strong and is used locally. The acorns are solitary and subsessile. The nut is ovoid in shape, apiculate, seated in the hemispherical cup which is covered with closely appressed scales.

Q. ilex Linn. is a small to moderate-sized evergreen tree which is often hardly more than a shrub. The coriaceous leaves, entire or with large spinescent teeth, dark-green above, softly white below, are very handsome. The tree is found in the inner arid valleys of the Himalayas between 4,000 and 8,000 ft. The acorns are solitary or in pairs. The nut is cylindrical, conical at the top, two and a half to three times as long as the half-inch hemispherical or conical cup.

Q. griffithii Hook. f. is a large deciduous tree with handsome coriaceous leaves. It is found in the eastern Himalayas with its western limit in Bhutan, and extends into the Khasi Hills and Burma. It is usually found in secondary forest, where it grows into a much-branched deciduous tree. It is usually found with *Q. serrata*, *Rhododendron arboreum*, *Pinus insularis* and others of the common secondary trees of the Assam-Burma border. Its wood is excellent and has a handsome grain. Acorns are rarely found and the gall-like growths on the branches are often mistaken for them. Acorns, when present, are subsessile in clusters of two or three near the apices of the branches. The nut is elongate-ovoid, about twice as long as the hemispherical cupule. This species is somewhat like the English oak.

Q. lanuginosa Don is a large evergreen tree, somewhat resembling *Q. incana* in appearance, but here the tomentum on the leaves has a reddish tinge. It extends along the Himalayas between 6,000 and 8,000 ft. where it usually occurs in dense pure patches and is often found clinging to limestone rock on precipices. The wood is hard but is used only as fuel. The acorns are solitary or in pairs, axillary, sessile. The ovoid-umbonate nut is covered in the lower half by the hemispherical cup.

Q. incana Roxb. is a moderate-sized to large evergreen tree with coriaceous dull-green leaves which are covered below with a

¹ See *Journ. Arn. Arboretum* (1941), pp. 572-3. A. Rehder submits that the correct name of this species is *Q. floribunda* Wall.

dense, white, felty tomentum. It is found all along the Himalayas as far as the Daffa Hills, between 4,000 and 8,000 ft. It is capable of growing on the most arid slopes and in such situations it is stunted and gnarled. In moist valleys it is a tall straight tree. The acorns are found solitary or in pairs, sessile or subsessile. The nut is ovoid in shape, tomentose at first, afterwards glabrous, entirely covered by the campanulate cupule when young; when mature about 1 in. long, half being exerted from the cupule.

Q. semiserrata Roxb. is a large tree found in the plains of Assam and Burma and up to 2,000 ft. in the Garo and Khasi Hills, usually in deciduous forest. The timber is little known but when cut on the quarter it has a handsome grain. The acorns are solitary and sessile. The nuts are elongate-ovoid, apiculate, smooth, 1.75 in. long, seated in hemispheric lamellate cups which are tomentose when young.

Q. glauca Thunb. A large handsome evergreen tree found along the outer Himalayas and also in the Naga and Khasi Hills, between the limits of 3,000 and 6,000 ft. It prefers moist situations but is usually associated with *Q. incana*, *Rhododendron arboreum*, *Lyonia* (*Pieris*) *ovalifolia*, with a sprinkling of *Pinus roxburghii*. The timber is not used and the main value of the wood is its suitability for fuel. The acorns are sessile and solitary, in pairs or in threes. The shining ovoid or cylindric-conic nut, 0.6-0.8 in. long, is seated in a lamellate cup which covers it for less than one half of its length.

Q. patkoiensis A. Camus is a tall tree found in the Patkoi mountains. Little is known of it.

Q. brandisiana Kurz is a small evergreen tree which is common in the drier hill-forests of Martaban in Burma, 1,000-4,000 ft. The acorns are few in number, seated on a short fruiting peduncle. The ovoid or conic-hemispheric nuts, broader than long, are seated in sessile hemispherical lamellate cupules which cover the lower two-thirds.

Q. lineata Bl. is a large evergreen tree with a thick brown bark, found in the mountains of the eastern Himalayas, extending into the Assam Hills and Burma. It is usually associated with *Q. lamellosa* and the timbers of the two have similar properties. The acorns of this species are solitary and sessile. The lamellate saucer-shaped cup covers approximately half the apiculate smooth and shining nut.

King cites five varieties.

Leaves strongly spinose-serrate:

Under-surface glaucous ... var. *oxyodon* (1)

Under-surface minutely fulvous-tomentose var. *lobbii* (2)

Leaves serrulate or entire:

Leaves subentire, much acuminate var. *griffithii* (3)

Leaves serrulate in the upper half or towards the apex:

Leaves ovate-lanceolate	var. <i>thomsoniana</i> (4)
Leaves elliptic-oblong	var. <i>hillebrandii</i> (5)

(1), (2) and (3) are confined to the Khasi Hills, (4) to Sikkim and (5) to Burma.

Q. mespilifolia Wall. is an evergreen tree found in the Arakan Yoma and at Ava. Little is known of it. The ripe nuts are seated in hemispherical lamellate cupules wider than deep.

Q. helferiana DC. is a small tree found in dry places in northern Burma between 2,500 and 3,000 ft. The depressed flattened nuts are about 0.75 in. broad and are seated on patelli-form thick flat cups with ten lamellae.

Q. velutina Lindl. is a moderate-sized tree found in Chittagong and Burma, where it is often an associate in the *Eng* forests of Burma. The lepidote-tomentose nut, seated in the shallow campanulate golden lamellate cup, is characteristic.

Q. lamellosa Smith is a very large evergreen umbrageous tree. It is consistently found in the eastern Himalayas and the mountains of Assam and Burma between 6,000 and 9,000 ft. where it is associated with other oaks, maples and magnoliaceous trees. The contrast between the dark-green upper-surface and the glaucous lower surface of the leaves makes this tree a very easy one to recognize. The large flat nuts, too, in their shallow saucer-shaped lamellate cups, are characteristic of this species. The wood is very hard and durable under cover and is used for building. It is a most excellent fuel.

Q. lanceaefolia Roxb. is a small to moderate-sized evergreen tree which is found in the plains of Assam and in the hills up to 5,000 ft. The wood is hard but is only used locally for building purposes. The tree is easily recognized from the acorns, in which the cupule is thin and ridged and entirely covers the nut.

Q. xylocarpa Kurz. This species is a middle-sized to large tree found in the mountains of eastern India in the neighbourhood of 7,000 ft. The ripe nuts are coalesced in masses of three, 2 in. in diameter or more. The cupules almost entirely cover the nut and are covered with hard conical projections.

Q. milroyi Purk. is an evergreen tree, found in the plains in evergreen forest, Pasighat, Sadiya, Assam. Acorns usually solitary, ellipsoid with a shallow depression at the apex. Cupule tuberculate outside, almost entirely enveloping the nut.

Q. truncata King is a common species found in the Naga Hills between 4,000 and 6,000 ft. The acorns are different from all others in the genus. The cups are woody, sessile, sub-hemispherical in shape, flat-truncate at the top, almost covering the whole of the nut.

Q. lindleyana Wall. is a small evergreen tree, apparently only found in Burma. Acorns sessile, fused together in groups

of three to six. Nuts two-thirds exserted from the cup, 0.65 in. long, cups hemispherical in shape.

Q. amherstiana Wall. A large evergreen tree found at Amherst in Burma. The cylindrical-conical nuts, covered when young with a minute brown scurfy tomentum, are seated in sessile cups, solitary or in groups of two or three, covering their lower halves. Little is known of this species.

Q. lappacea Roxb. is a small or moderate-sized somewhat gregarious tree found in Assam and Burma, ascending in the hills to 4,000 ft. The nuts, which are conic-ovoid in shape, are half-enveloped by the cup, which is covered on the outside by the long thin spreading free apices of the bracts.

Q. acuminata Roxb. is an evergreen tree found in the Chittagong hill-tracts. The nuts are broadly ovoid in shape and are seated in solitary cups which cover the lower half. The outside of the cups exhibits the tips of the hooked bracts.

Q. pachyphylla Kurz is a very large evergreen tree found in the eastern Himalayas, 6,000-10,000 ft., and also in the Assam hills. In Manipur a distinct variety, var. *fruticosa*, is found which is little more than a bush. Its associates in the Sikkim hills are *Engelhardtia spicata* and *Schima wallichii*. The fruiting spikes are covered with woody coalesced groups of three or six acorns. Each acorn is about 1-1.5 in. in diameter, the cupule embracing the greater part of the nut. This species is largely used in the Naga Hills for building. It is also considered to be an excellent firewood.

Q. fenestrata Roxb. A tall evergreen tree, common in the eastern Himalayas and in the Assam and Burma hills. Ripe acorns solitary by abortion, or in threes, much crowded. The rufous-pubescent cups almost entirely cover the sub-globular apiculate nuts and are thin and crustaceous in texture. Apices of the cup-scales free, hooked, the bases connate.

Q. dealbata Hook. f. et Thoms. is a small tree which is common in the Khasi and Naga Hills and probably extends into Burma. It is used as a fuel. Acorns solitary or two or three together on a stout rhachis. The woody cupule almost completely envelops the globose or turbinate nut.

Q. spicata Smith is a widely distributed species, extending eastwards from Nepal into all the hilly regions of Assam and Burma and on into Malaya, ascending in the hills to 10,000 ft. A number of varieties are recognized but they do not seem to be very stable. The nut is depressed-globose or ovoid-conic, seated in a saucer-shaped cup which at the most only covers one third of the nut.

Q. polystachya Wall. is a small evergreen tree which extends from the eastern Himalayas into Burma. King says this tree is truly dioecious. Little is known about it. The acorns are solitary on the rhachis, with one or two aborted ones below each.

The nuts are subglobular, apiculate, smooth and shining, about half an inch long, and are seated on discoid cupules which often embrace the very base.

Q. eumorpha Kurz is a scraggy evergreen tree 15-30 ft. tall, found in Burma only. The ovoid-conic nuts, crowned with the remains of the united styles, are seated in the fulvous-tomentose hemispherical cupules which envelop only the lower third.

Q. thomsoni Miq. is a very large tree often reaching a height of 100 ft., resembling *Q. dealbata* in the leaves but differing considerably in fruit. The globose or pyriform nut is seated in a woody saucer-shaped cup which only envelops the lower third of it. The acorns are solitary on the stout rhachis.

2. *Castanopsis* Spach. This genus, which is with difficulty separable from *Quercus* unless the fruits be at hand, contains some nine species in India and Burma.

The following is a key to the species (after King).

Fruit dehiscent:

Walls of the involucre completely hidden by subulate spines:

Leaves pubescent or minutely tomentose on the lower surface:

Margins of leaves serrate:

Nerves 10-16 pairs:

Leaves rufous beneath ... *C. indica*

Leaves pale beneath ... *C. clarkei*

Nerves 7-9 pairs ... *C. hystrix*

Margins of leaves entire ... *C. diversifolia*

Leaves glabrous on both surfaces:

Leaves lanceolate, glaucous beneath ... *C. argentea*

Leaves ovate-oblong, not glaucous ... *C. castanicaarpa*

Walls of involucre bearing spines in tufts or ridges:

Spines in tufts ... *C. argyrophylla*

Spines in ridges:

Leaves glabrous, entire:

Spines short, thick; involucre tomentose

C. armata

Spines large, branched; involucre glabrous

C. birmanica

Leaves with a ferruginous pubescence below; margins entire or serrate ... *C. tribuloides*

Fruit not dehiscent:

Leaves glabrous on both surfaces .. *C. rhamnifolia*

Leaves flocculent-pubescent beneath ... *C. wallichii*

C. indica A. DC. is a moderate-sized to large evergreen tree with serrate leaves and silvery-grey warty fissured bark, which is found in the eastern Himalayas from Nepal eastwards and is very common in the plains and hills of Assam up to 4,000 ft.

The nuts are edible and are enclosed in involucre 1-1.5 in. in diameter, covered with pubescent subulate prickles. The wood can be easily split and is used for shingles.

C. clarkei King is a tree from the Sikkim Himalayas ; little is known of it. King says it is a connecting link between *C. indica* and *C. hystrix*.

C. hystrix A. DC. is a large evergreen tree reaching a height of well over 100 ft. It is easily recognized by the reddish undersurfaces to the leaves. The ripe involucre are more or less 4-angled and measure about 2 in. in diameter. The wall of the involucre is thick, and is covered with numerous simple or branching spines, which have pubescent stems but glabrous tips.

C. diversifolia (Kurz) King is a tree up to 60 ft. tall with the adult leaves much smaller and firmer than the young leaves. The fruit is sessile and globular, 1.5 in. in diameter. The involucre is distinctly ridged and covered with stout pubescent radiating sharp spines, 0.4 in. long. This tree is confined to North Burma.

C. argentea A. DC. is a moderate-sized evergreen tree which seems to be found only in Assam and Burma in the hills between 6,000 and 7,000 ft. The silvery under-surface to the leaf and pruinose branchlets are very characteristic of this species. The ripe fruit is sessile and 2 in. in diameter. The involucre is covered with numerous tufts of branched radiating spines with pale tips and ash-coloured stems. This tree is found in Burma (Toungoo) and in the Khasi Hills, Assam.

C. castanicaarpa Spach. is a moderate-sized evergreen tree with rather large leaves. The ripe fruit is ovoid in shape and the pubescent involucre is densely covered with sharp, rather weak spines, connate at their bases only, about 0.5 in. long. It is found only in Chittagong.

C. argyrophylla King. Little is known of this species which, King asserts, has not been collected since Wallich's time. According to him it is nearest to *C. argentea* but differs from it by the pubescent young shoots and the densely fulvous tomentose nuts. The nuts in *C. argentea* are appressed-pubescent. The nuts, however, are very characteristic in this species. They are about 0.5 in. in diameter and of a peculiar black colour with brown simple spines. The fruits of *C. argentea*, on the other hand, are much bigger and the spines frequently branch. This tree seems to be common on the Maymyo plateau in spite of what King says.

C. armata Spach. is a very large evergreen tree which can reach 100 ft. in height. It is found in the Khasi Hills of Assam, and doubtless elsewhere in the State and in the Chittagong district of East Bengal. The fruit, which is ellipsoid or globular in shape, is covered with a dense fine fulvous tomentum. The

spines are short, stout, branched and are set upon the involucre in rows.

C. birmanica A. Camus is a tree from Myitkyina with oblanceolate leaves and large fruits, 1.5-2 in. in diameter. The spines are very stout and stellately branched. Little is known of this tree.

C. tribuloides A. DC. is a moderate-sized evergreen tree with a very wide distribution, found in the plains and up to 6,000 ft., extending from the Ganges eastwards into Bengal, Assam, Burma and the Naga and Khasi Hills. There are five varieties of this tree.

C. rhamnifolia A. DC. is a small tree found in Burma. The ripe fruits are flattened on one side and there are no spines on this spot. The rest of the involucre is covered with conical tomentose spines.

C. wallichii King is an evergreen tree from Burma which is similar to the last named but has different leaves and involucre which are more spinous.

3. *Castanea* Tour. This genus is represented in India by the species *C. sativa* Miller, the Spanish or Sweet Chestnut. This deciduous tree, which is indigenous to southern Europe, has been introduced into India where it does well in the Himalayas up to 6,000 ft. In India it only reaches a moderate size and branches low down. This tree is grown in many of the hill-stations of the north-western Himalayas and also does well at Dehra Dun. The ripe fruits are 3 in. in diameter and the involucre is densely covered with long spines.

16. JUGLANDALES

Trees ; flowers monoecious ; ovary inferior, 1-locular, 1-ovuled ; stamens 3-40 ; endosperm absent.

32. JUGLANDACEAE

Trees. Leaves alternate, often resinous and aromatic, imparipinnate, or paripinnate, exstipulate. Inflorescence of pendulous or erect catkin-like spikes. Flowers unisexual, monoecious, the male in pendulous spikes, the female in erect spikes. Male flowers ; each flower in the axil of a bract consists of a 3-6-lobed perianth with imbricate lobes or perianth absent ; stamens 3-40 ; filaments inserted at the base of the perianth, short ; anthers 2-locular, opening by longitudinal slits ; rudimentary ovary rarely developed. Female flowers ; calyx adnate to the ovary, free at the apex, 4-toothed or shortly 4-lobed ; ovary inferior, 1-locular ; style short, often plumose ; ovule one, erect from the base. Fruit a drupe or rarely a nut ; exocarp succulent ;

endocarp mostly hard, bony. Bracts and bracteole often enlarged and wing-like. Seed solitary, without endosperm.

There are two genera of this family in India.

Fruit a drupe with a bony endocarp ; leaves imparipinnate

1. *Juglans*

Fruit a nut attached to a large 3-lobed bract; leaves usually paripinnate by abortion of the terminal leaflet

2. *Engelhardtia*

1. *Juglans* Linn. *J. regia* Linn., the Walnut, is a large deciduous aromatic tree. Bark grey with longitudinal furrows on old stems. The tree is distributed all along the Himalayas, penetrating into the Naga Hills and the hills of Upper Burma. It is widely cultivated in the western districts of the Himalayas, but in the Naga Hills, Aka Hills and other places it is found wild in evergreen climax forest. The timber is, of course, well known and is prized for making furniture, carved tables, gun-stocks and other articles. The trees sometimes bear burrs and these fetch a very high price for veneers. The fruit commands a ready market, the best strain being the so-called *Kaghazi* variety. The fruit of the wild tree is useless.

2. *Engelhardtia* Lesch. This is a small genus of evergreen trees of which several species are found in India. The pendulous racemes of fruits, each with a 3-lobed wing, and pinnate leaves distinguish this genus from all others. *Carpinus* (*Corylaceae*) has a 3-lobed wing to the fruit but a simple leaf.

The following is a key to the Indian species.

Nuts glabrous:

Male flowers in terminal spikes; peltate golden glands present ... *E. polystachya*

Male flowers in paniced spikes ; peltate golden glands absent ... *E. wallichiana*

Nuts hairy:

Nuts hispidly hirsute ; leaflets sessile ... *E. acerifolia*

Nuts villous ; leaflets petiolulate:

Middle lobe of bract up to 3 in. long ... *E. spicata*

Middle lobe of bract up to 2 in. long ... *E. colebrookiana*

E. polystachya Radk. is a middle-sized or large tree with a fluted stem ; bark dark-brown, rough, longitudinally fissured ; blaze fibrous, light-yellow, turning deep-amber. The tree is found in the plains and hill-districts of Assam. The bark is used to intoxicate fish.

E. wallichiana Lindl. is found in the Khasi Hills ; little is known of it.

E. acerifolia Bl. is a middle-sized deciduous tree of the lower hill-forests of Assam and Bengal. The bark is smooth, grey, with vertical cracks ; blaze pink and white in streaks.

E. spicata Bl. is a large deciduous tree with a smooth grey bark and pink and white blaze. This is a common tree in the Himalayas between 4,000 and 6,000 ft. extending to Burma and the Assam hills. The wood is reddish-grey in colour and is used for tea-boxes and wood-carving. The Garos raise crops of lac on the trees. The bark is used to intoxicate fish.

E. colebrookiana Lindl. is a small deciduous tree with tomentose shoots, found all along the Himalayas up to 5,000 ft. The wood is grey with a reddish tinge, but is not used.

17. CASUARINALES

Trees ; flowers monoecious or dioecious, in male spikes or female heads ; calyx and petals absent ; ovary superior, 1-locular, 2-ovuled ; stamen solitary ; embryo straight ; endosperm absent.

33. CASUARINACEAE

Trees with branches jointed after the fashion of *Ephedra*. The function of the leaves is undertaken by the noded branches and the leaves themselves are reduced to many-toothed sheaths surrounding the nodes of branches. Inflorescences monoecious; male of catkin-like erect flower-spikes with the flowers in whorls; female of flowers crowded at the ends of short lateral branches. Flowers monoecious. Male flowers ; a single central stamen seated in the axil of a bract which, with other bracts, forms a protective sheath or perianth for the young flowers; filament at first short, thin, elongating; anthers 2-locular, opening by longitudinal slits. Female flower solitary in the axil of a bract with a pair of bracteoles ; ovary bicarpellary ; ovary 1-locular; ovules two, parietal, only one of which develops into a seed ; stamens two, long. Fruits crowded into a woody globose cone with persistent bracts ; the bracts opening like a capsule and exposing the samaroid indehiscent nut. Seed solitary without endosperm ; embryo straight. This is a monotypic family with one genus, *Casuarina* Forst.

C. equisetifolia Forst. is a large evergreen tree with characteristic feathery foliage, giving the impression of being a coniferous tree. The blaze has the colour of raw meat. Young specimens are confused by students with species of *Tamarix* and *Ephedra*. The 6-8-ribbed branches distinguish *Casuarina* from the other two genera. This tree, which under favourable circumstances reaches a height of 130 ft. or more, is indigenous on the sandy shores of Chittagong, Burma and the Andamans. It has been used successfully to stabilize sandy coast on the shores of Madras State. This species is capable of colonizing

bare sand on the seashore, where the seedlings appear to revel in the light and heat of the tropical sun. Actually it will eventually be replaced by something else if allowed to grow into a forest, for the young *Casuarina* seedlings are not able to germinate and grow even in the light shade thrown by the parent trees. It is one of the most rapid growers of any of the Indian trees. It has, however, also been grown with success inland, and as the wood is highly esteemed for fuel, profits from the sale of the wood are high. It is said to be the best firewood in the world and will even burn when green. It should be borne in mind that this is one of the species with root-nodules containing bacteria, and that, if it is proposed to raise this tree in any area from which it is naturally absent, it is advisable to transfer a little soil from an old plantation to the new site. The bark can be used for tanning.

As has already been stated the branchlets fulfil the functions of the leaves. These branchlets are jointed and 6-8-ribbed; stomata are found at the bottom of the furrows only and are surrounded by fine hairs. The ribs of each joint terminate upwards in the teeth of a membranous sheath, which alternate with the ribs of the joint next above.

Apart from *C. equisetifolia* Forst. several other species of *Casuarina* are cultivated in India. *C. montana* Jungh. var. *validior*, which is indigenous on the mountains in Java, is cultivated in north-west India and does well. A few other species, *C. quadrivalvis* Labill., *C. suberosa* Ott. et Diet. and *C. glauca* Sieb., have been planted in the Nilgiris.

From experiments carried out at the Forest Research Institute and written up by Aldrich-Blake¹ it has been proved beyond all reasonable doubt that *Casuarina equisetifolia* may be added to the increasing list of plants which obtain atmospheric nitrogen through symbiotic bacteria in the roots. Aldrich-Blake recommends that this species should be used as a host for the sandal tree, and that plantations on sandy sea-coasts should be encouraged. Further, when introduced into areas outside its natural range the specific bacterium should be provided. To ensure that this is so, crushed nodules mixed with soil may be added to the seed-bed.

18. URTICALES

Trees, shrubs or herbs; flowers hermaphrodite, dioecious or monoecious; ovary superior, 1-2-locular; stamens few; embryo straight; endosperm absent.

¹ R. N. Aldrich-Blake in *Oxford Forestry Memoirs*, vol. 14, 1932, Clarendon Press.

34. ULMACEAE 35. MORACEAE 36. URTICACEAE
37. CANNABINACEAE

34. ULMACEAE

Trees or shrubs. Leaves distichous, alternate, simple, penninerved, scabrous, often unequal-sided, stipulate; stipules caducous. Inflorescence of fascicled flowers. Flowers hermaphrodite, or unisexual, actinomorphic. Perianth herbaceous or slightly coloured, sub-campanulate, 4-8-lobed; lobes imbricate, persistent. Stamens inserted at the bottom of the perianth, equal in number to and opposite its lobes; filaments free; anthers 2-locular, opening by longitudinal slits. Ovary composed of two connate carpels, 1-2-locular; ovules solitary, pendulous from near the top; styles two, divergent, stigmatose on their inner surfaces. Fruit a membranous samara (*Ulmus*) or a more or less rounded drupe (*Celtis*). Seed without endosperm; embryo straight.

Key to the genera of *Ulmaceae*

Fruit a samara:

- | | | |
|----------------|-----|----------------------|
| Leaves serrate | ... | 1. <i>Ulmus</i> |
| Leaves entire | ... | 2. <i>Holoptelea</i> |

Fruit drupaceous, not a samara:

- | | | |
|------------------------------|-----|----------------------|
| Leaves 3-nerved: | | |
| Leaves and shoots very rough | ... | 3. <i>Trema</i> |
| Leaves and shoots smooth | ... | 4. <i>Celtis</i> |
| Leaves penninerved | ... | 5. <i>Gironniera</i> |

1. *Ulmus* Linn. The Elm tree. There are about five species in India, but only three of them are common.

Samara about 1 in. long ... *U. lancifolia*

Samara much less than 1 in. long:

Mature leaves scabrid above, very oblique at the base
U. wallichiana

Mature leaves smooth, subequal or slightly oblique at the base
... *U. laevigata*

U. lancifolia Roxb. is a middle-sized to large deciduous tree of the foot-hills of the eastern Himalayas and Assam hills up to 4,000 ft. The bark is greyish-brown in colour, rough, somewhat corky, exfoliating in flakes; blaze reddish, turning yellow. The wood is not used.

U. wallichiana Planch. is a large tree with a thick rough grey bark, deeply furrowed. This tree is found in the western Himalayas from the Indus to Nepal. The timber is yellowish-brown in colour with a handsome grain and takes an excellent polish. It is a very good furniture wood.

U. laevigata Royle (*U. villosa* Brandis) is a medium-sized to

large tree found in the Himalayas from the Indus to the Jumna between 3,500 and 10,000 ft. This tree produces root-suckers to an extraordinary extent and probably it reproduces itself principally in this way, for the seed is said to fall off the tree before it is ripe. The timber does not appear to have any particular value. The branches are, however, lopped for fodder.

U. procera Salisb. is the common English Elm and is found in Baluchistan and sometimes cultivated (Rawalpindi).

2. *Holoptelea* Planch. There is only one species, *H. integrifolia* Planch., of this genus in India. This species is a large deciduous tree somewhat resembling a beech tree in general appearance. It is widely distributed in India, ascending to 2,000 ft. in the hills, and extends to northern Burma. The bark is grey and fairly smooth; blaze cream, streaked with light-brown, with an unpleasant odour. The crushed leaves and twigs have also the same unpleasant smell. The wood is yellowish-grey and is fairly hard, but it is only used locally. The leaves are lopped for fodder.

3. *Trema* Lour. The two Indian and Burmese species can be separated by the following key. The leaves are 3-nerved.

- | | |
|---|--------------------------|
| Leaves softly tomentose beneath; cymes spreading, longer than petiole | ... <i>T. orientalis</i> |
| Leaves very rough on both sides; cymes compact, not longer than petiole | ... <i>T. politoria</i> |

T. orientalis Bl. is a small tree reaching 30 ft. in height. It grows very rapidly but is short-lived. It is found in most parts of India. The bark is soft, greyish or bluish-green, rough with numerous lenticels; blaze deep-red, streaked. This tree, like *Macaranga denticulata*, often appears gregariously on abandoned hill-fields, landslips and the like. It is apt to be mistaken for *Grewia disperma*, but the leaves of the latter taper at the base, while those of *Trema* are almost cordate. The wood of this species is soft but is valued for its excellence as a source of gunpowder charcoal. The species of *Trema* known as *T. amboinensis* Bl. is now considered to be a variety of this species.

T. politoria Planch. is a small evergreen tree found in the sub-Himalayan tract, Madhya Pradesh and eastwards into Assam and Burma. Like the former species it is very common on landslips and other places which have been recently cleared. The leaves are very harsh to the touch and are used for polishing wood. The wood is not used.

4. *Celtis* Linn. *C. australis* Linn. (*C. caucasica* Willd.; *C. eriocarpa* Dcne.) is a tree found in the north-west Himalayas between 2,000 and 8,500 ft., where it is common, both wild and cultivated. It is a moderate-sized deciduous tree with characteristic leaves oblique at the base and 3-nerved. The bark is

smooth, bluish-grey, wrinkled on old trees; blaze chocolate with lighter specks. According to Troup it is interesting because it ascends to high altitudes and also is at home in swamps. The branches are much lopped for fodder. The wood although tough and hard is little used. Three other species are found in India and Burma.

The following is a key to them.

Leaves with one or more strong primary nerves above the basal ribs, membranous, very oblique, usually sharply serrate nearly to the base, acutely acuminate or cordate

C. tetrandra

Leaves without strong primary nerves above the basal ribs:

Twigs reddish-brown, lenticellate; leaves chartaceous or sub-coriaceous, entire; pubescence ferrugineous

C. cinnamomea

Twigs greyish-brown, not lenticellate; leaves rigidly coriaceous, crenate-serrate; pubescence grey *C. wightii*

C. tetrandra Roxb. A middle-sized tree widely distributed in India and Burma. The bark is greyish, lenticellate, horizontally wrinkled; blaze hard, dark-brown with specks and lines of lighter coloured tissue. The timber is not used.

C. cinnamomea Lindl. is a middle-sized tree found in the Deccan Peninsula, Bihar, Assam, the Andamans and doubtless elsewhere. It is a middle-sized tree with grey, rough and warty bark, covered with horizontal bands of lenticels; blaze dark-brown or black, hard, mottled yellow, with an unpleasant odour. The wood of this species has a disgusting smell due to the presence of skatol. Chips of the wood are sold in Bombay and are used as a fumigatory against evil spirits.

C. wightii Planch. is a tree very similar to the preceding and perhaps not specifically distinct from it. It is found in similar localities to the last-named species.

5. *Girouneria* Gaud. A genus which can be very readily recognized in the forest when in fruit. This consists of a fleshy orange-coloured spherical portion surmounted by two long hairs. There are three species of this genus in India.

Leaves strigose beneath ... *G. subaequalis*

Leaves glabrous beneath:

Young shoots minutely strigose; venation conspicuous

G. cuspidata

Young shoots glabrous; venation obscure; leaves very glossy ... *G. lucida*

G. subaequalis Planch. is a small evergreen tree found in the Andamans.

G. cuspidata Kurz (*G. reticulata* Thw.) is a very large evergreen tree with a buttressed base and cinnamon-brown coloured

bark, exfoliating in loose irregular projecting flakes; blaze finely fibrous, rosy-pink in colour with streaks of lighter coloured tissue, light-red beneath the corky layer. This tree is found in the climax forests of the Western Ghats, Assam and Burma. The wood is reddish or brown in colour, hard, and is capable of taking a good polish. It deserves to be more widely used.

G. lucida Kurz is a moderate-sized evergreen tree found in Burma and the Andamans. The bark is dark-brown and rough; blaze reddish-brown with irregular white streaks. The wood does not appear to have any uses.

35. MORACEAE

Trees or shrubs, often with a copious milky juice. Leaves simple, alternate, rarely opposite, penninerved or palminerved, stipulate; stipules caducous, leaving a scar. Inflorescence mainly cymose, of heads of flowers crowded on a receptacle. Flowers unisexual, monoecious or dioecious, mostly in a persistent perianth. Perianth 4-lobed; lobes imbricate or valvate, free or connate. Male flower; stamens equal in number to and opposite to the calyx-lobes; filaments straight or inflexed in the bud; anthers 2-locular, opening by longitudinal slits; rudimentary ovary present or not. Female flower; ovary superior to inferior, of two carpels, one sometimes not developed, usually 1-locular; ovule solitary, pendulous from the apex, rarely basal and erect; styles mostly two, filiform. Fruit a nut, achene or drupe. Seed with or without endosperm; embryo curved.

Key to the genera of *Moraceae*

- | | | |
|---|-----|------------------------|
| Fruit a fig (hypanthodium) | ... | 1. <i>Ficus</i> |
| Fruit not a fig: | | |
| Fruit a syncarpium: | | |
| Climbing shrubs | ... | 2. <i>Conocephalus</i> |
| Trees or shrubs: | | |
| Unarmed trees: | | |
| Leaves penninerved: | | |
| Receptacle of male inflorescence with one flower | | 3. <i>Artocarpus</i> |
| Receptacle of both male and female inflorescences with many flowers | ... | 4. <i>Castilla</i> |
| Leaves palminerved: | | |
| Achenes enclosed in a fleshy syncarpium | | 5. <i>Morus</i> |
| Achenes on long fleshy stalks | | 6. <i>Broussonetia</i> |
| Armed shrubs: | | |
| Stamens included; syncarpium many-seeded | | 7. <i>Cudrania</i> |
| Stamens exserted; syncarpium few-seeded | | 8. <i>Plecosperrum</i> |

Fruit resulting from one flower:

Unarmed trees or shrubs:

Glabrous

... 9. *Pseudostreblus*

Hairy:

A tall tree with velvety shoots

10. *Antiaris*

A small tree with harsh leaves

11. *Streblus*

More or less armed

... 12. *Balanostreblus*

1. *Ficus* Linn. This enormous genus is well represented in India, where many climbing, epiphytic and tree species are found. The flowers are of great interest as they show in a remarkable manner to what lengths mutual adaptation can be carried, in order to ensure cross-pollination. The flowers of *Ficus* are collected cymosely on the inner surface of a fleshy flask or receptacle which is formed from the curving of the fleshy axis. These receptacles may be borne on the branches or on the trunks or even underground on root-like branches. The mouth of the flask is closed by overlapping and coalescent bracts. The flowers, which are mostly unisexual, are collected on the inner walls of the receptacle. The flowers may be either sessile or pedicellate and are often separated from one another by hairs or scales. Five kinds of flowers are found in the genus. King calls them male, pseudo-hermaphrodite, neuter, fertile flowers and gall-flowers.

The perianth of the male flower consists of 2-6 united or connate lobes which are longer or shorter than the stamens. In the majority of species there is only one stamen; as many as three in a few species. The anthers are 2-locular and open by longitudinal slits.

Pseudo-hermaphrodite flowers are like male flowers but possess a pistil in addition. The seeds, however, are not found in these flowers.

Female fertile flowers possess a perianth similar to that of the male or reduced; lobes connate or sometimes free. The ovary is often pedicellate, 1-locular, enclosing a single pendulous ovule; style long, slender; stigma various. Fruit an achene with scanty endosperm.

The gall-flowers resemble female flowers but differ from them in certain respects. These flowers are nearly always selected by hymenopterous insects (*Chalcididae*) in order to oviposit in. Soon these flowers become distorted and a pupa can be seen inside them. The fruits (figs) of many species often contain large numbers of the newly hatched insects. The gall-flowers are readily seen if a ripe fig is broken open because a fair number of the flowers on the wall of the fruit will look like little stalked bladders. Each of these will have a hole in it which marks the spot from which the parasitic adult insect has emerged.

Neuter flowers are found only in a few species. They are

seated on a long pedicel and have a 3-lobed perianth, without a trace of anther or ovary.

The pollination of the female flowers is certainly carried out by the chalcid insects referred to above, which brush against the male flowers as they pass down the receptacle to escape through the opening at the top.

Since the cross-pollination of the flowers of *Ficus* is such an extraordinary phenomenon it is interesting to follow the complicated chain of events which leads up to the culmination of the mutual interdependence of insect and plant. First of all, however, it is as well to realize that one species of insect is adapted to one species of tree only; secondly that one species of tree may develop two kinds of figs, one which contains male and gall-flowers, the other with female flowers only; these figs may be on different trees; thirdly that the ovipositor of the insect can reach the ovary of the gall-flower but not that of the female flower; fourthly that the insects are adapted to this existence and to no other. If their species of tree is not available they die out and conversely, if they are not present, the tree will not set seed.

Inside a fig that has been parasitized the little bladder-like gall-flowers contain the larvae of the chalcid insects. When full fed these insects emerge, male and female. Mating takes place within the fig and the males, blind and wingless, die, their span of life outside the gall-flowers being only a few hours. The female insects, fertilized, now make their way to the mouth of the fig and in so doing brush against the anthers of the male flowers, which are ripe just at this time. They emerge from the fig carrying a load of pollen and a load of eggs and fly to the nearest developing fig, scramble through the opening and proceed to lay eggs in as many ovaries as possible. The efforts of the female to oviposit in a female flower certainly results in pollen being transferred to the stigma. The egg laid in the ovary of the gall-flower hatches into a maggot, ready to start the cycle once again. How such an amazing series of events, each occurring at the correct time, has originated, has up to the present not been adequately explained.

If a fig be opened it is unusual not to find a number of the parasitic insects inside. Occasionally there will also be seen another type of insect with a long hair-like ovipositor at its posterior end. This is a parasite on a parasite, an ichneumon, which lays its eggs upon the developing larva of the chalcid. It drives its ovipositor through the wall of the fig and somehow or other finds the larva and lays its egg on it.

Many species of *Ficus* start their existence as epiphytes and having strangled their support subsequently become self-supporting trees. Others are erect trees while still others are never more than twiners and climbers.

As there are about eighty species of *Ficus* in India and Burma it is not possible to give a key to all the species. The following trees, however, are of interest and importance.

F. benghalensis Linn. is the Banyan, a wide-spreading tree of low stature. It is well known from the descending aerial roots which, having gained contact with the soil, grow into the trunks which support the wide-spreading canopy. In exceptional cases this reaches a diameter of 100 yards.

F. religiosa Linn., the Pipal, starting life epiphytically, reaches a considerable size after strangling the host. This tree is sacred to both Hindus and Buddhists. The lac-insect can be cultivated on the bark.

F. roxburghii Wall. is a small tree of Assam and Burma which produces figs at the base of the trunk. They are excellent for eating or making into jam.

F. elastica Roxb. is the Indiarubber tree, which was at one time largely cultivated in Assam as a source of rubber. It cannot compare with the produce of *Hevea brasiliensis*, and when the latter tree was cultivated on a large scale the tapping of *F. elastica* ceased.

F. infectoria Roxb., *F. retusa* Linn., *F. benjamina* Linn. are often cultivated for their foliage and shade.

2. *Conocephalus* Bl. is a small genus of woody climbers, of which one species, *C. suaveolens* Bl., is found in India. This species is a large evergreen climber, with a woody stem, found in the evergreen forests of eastern India and Burma. The bark is dark-grey with white patches; blaze reddish, turning brown. The leaves are often large with dotted cystoliths above and raised lines beneath. The leaves, when cooked, are eaten in Assam.

3. *Artocarpus* Forst. An important genus with several species in India. An interesting characteristic of the species is that, although the mature leaves are entire, the leaves of seedlings and coppice shoots are often deeply lobed or pinnatifid.

The following is a key to the Indian species.

Fruit smooth:

Leaves glabrous; fruit up to 1.25 in. in diameter

A. gomeziana

Leaves hairy below; fruit 2-4 in. in diameter, yellow, velvety

... *A. lakoocha*

Fruit tubercled:

Leaves quite glabrous; fruit very large ... *A. integra*

Leaves hairy:

An evergreen tree of the Western Ghats *A. hirsuta*

A deciduous tree of north-east India; leaves harsh with stiff hairs ... *A. chaplasha*

A. gomeziana Wall. is a rather rare species with glossy, dark, evergreen leaves, found in Assam and the Andamans. It grows into a large-sized tree with dark-coloured corky-fissured bark; blaze milky, light-red with white streaks. The wood is yellowish, hard and durable, and is probably sold as Chaplash, the trade name of *A. chaplasha*.

A. lakoocha Roxb. is a large deciduous tree with a spreading crown and grey bark, flaking in small scales; blaze red, followed immediately by drops of milk. The tree is found in the moister forests of India. The timber is valuable and is sold under the trade name of Lakooch.

A. integra Merr. (*A. integrifolia* Linn. f.) is the well-known Jack tree, which is planted all over India for the sake of its fruit. It is wild in the forests of the Western Ghats but elsewhere it only appears as a cultivated tree. The bark is black, mottled with green or dark-brown in colour, rough with warty excrescences; blaze pale-pink or yellow, streaked with white, exuding a copious milky latex. The fruit, borne on the trunk and old branches, often reaches enormous size, weighing up to 80 lb. Sometimes the fruits are to be found below the surface of the earth. The fruit is highly esteemed by Indians and Burmese, the flavour being, according to Burkill, that of ethyl butyrate. The boiled seeds taste, according to the same authority, like chestnuts. The timber is excellent and is sold under the name of Jack. A dye can be obtained by boiling the wood, and the saffron-coloured robes of Buddhist priests are dyed with it.

A. hirsuta Lam. is a very tall evergreen tree with a long straight bole, found in the evergreen climax forests of the Western Ghats. It has a grey smooth bark; blaze with latex. The wood is valuable and is sold under the trade name of Aini.

A. chaplasha Roxb. The Chaplash. A very large deciduous tree which is common in Bengal, Assam, the Andamans and in Lower Burma. The stem is greyish, regular and straight with a yellowish blaze. The young stems and leaves are very rough to the touch and the young shoots are covered with stiff hairs. This tree is interesting because the juvenile leaves are totally different from those of a mature tree. The latter are almost elliptic in shape and coriaceous in texture, not more than 10 in. long. Those from young plants and coppice shoots are up to 3 ft. long, membranous in texture, and the blade is lobed, serrate or even pinnatifid. This tree yields a very fine timber. It is a very rapid grower and this fact, combined with the ease with which it can be propagated, has led to its extensive use in plantations. Plantations of this species, however, seem to attract elephants just as honey attracts bees, and has of necessity altered the technique of raising the tree. Pure plantations are no longer favoured in areas where elephants are a danger.

4. *Castilla* Cerv. (*Castilloa* Cerv. ex Koenig). This genus has up till recently been known as *Castilloa* but, according to Burkill, the name, as written by Cervantes himself, was *Castilla*. *C. elastica* Cerv., the Mexican Rubber-tree, was introduced into India in the last century and some trees may still be found at Yellapur in Bombay State near the rest-house. The tree is very easily recognized by its oblong-cordate pendulous leaves on horizontal branches and the very copious milky exudation from the blaze. At first sight the tree looks somewhat like *Duabanga sonneratioides*. The rubber produced by this tree cannot be compared with that given by *Hevea*.

5. *Morus* Linn. is a small genus with several species in India. *M. alba* Linn., the Mulberry, and *M. indica* Linn. are cultivated, the former for its fruit and both for their leaves, which form the food of the silkworm. *M. alba* is probably indigenous to China but is naturalized throughout India. The two species are very close together and perhaps the chief points of distinction are the connate styles and obovate sepals in the female flower in *M. indica*. In *M. alba* the styles are free to the base and the sepals not obovate.

Another species found in the Punjab is *M. serrata* Roxb. This species grows into a large deciduous tree with reddish or reddish-brown bark, smooth on young, scaly on old stems. The timber is excellent for furniture and takes a beautiful polish. *M. laevigata* Wall. is a large deciduous tree, common in Assam and Burma. The bark of young trees is brownish-grey, that of old trees is rough, dark-brown, divided by horizontal and vertical fissures into square flakes; blaze white, mottled and layered with brown; latex copious. The tree gives a timber which is hard and even-grained, yellowish-brown in colour, and valued for furniture, cars, etc. The fruit is not to be despised, and is excellent stewed with sugar.

6. *Broussonetia* Vent. *B. papyrifera* Vent. is a tree which is indigenous in China and Upper Burma but it is now naturalized in many parts of India. It is a large deciduous tree with smooth grey bark. The inner bark is very good for paper but the expense of collecting it is great. It is a remarkably fast grower and reproduces itself freely in suitable places.

7. *Cudrania* Trécul. This is a small genus of spiny shrubs with milky juice. There are two common species in India.

Young branches pubescent	... <i>C. javanensis</i>
Young branches glabrous	... <i>C. fruticosa</i>

C. javanensis Trécul is a scrambling spiny shrub found in the sub-Himalayan tract from the Jumna eastwards into Assam, Bihar and Burma. The wood gives a yellow dye. This species is often mistaken for *Plecosperrum spinosum* Trécul (q.v.).

C. fruticosa Wight. This scrambling or rambling shrub is found in the Khasi and Naga Hills at 4,000 ft. The spines are said to be poisonous.

8. *Plecosperrum* Trécul. A small genus of spiny shrubs with milky juice. Our common species is *P. spinosum* Trécul and it is widely distributed in India. It is extremely like *Cudrania javanensis*, but the following differences will separate them even without flowers. In *Plecosperrum* the areoles formed by the secondary nerves are occupied by much-branched nervules whereas the nervules are mostly truly and closely reticulate in *Cudrania*; in *Plecosperrum* the leaf-tip is rounded or acute, in *Cudrania* always mucronate from the excurrent midrib. When flowers are present the female heads in *Cudrania* are globose as against angled in *Plecosperrum*. *P. andamanicum* King is indigenous to the Andamans. It is a large woody climber with yellowish furrowed stems and bark peeling off in small flakes. The spines are long and sharp and are poisonous.

9. *Pseudostreblus* Bur. *P. indica* Bur. is a middle-sized evergreen tree found in evergreen climax forests of the Surma Valley of Assam and in the Khasi Hills up to 5,000 ft. The bark is whitish or greenish-grey, verrucose; blaze fibrous, dull-white turning greenish-black, exuding a copious white latex which turns black. The fruits are edible. The timber is reported to be excellent, and suitable for cabinet-work.

10. *Antiaris* Lesch. *A. toxicaria* Lesch. is the famous Upas tree of legend and fairy-tale. This giant tree is widespread but not common in the evergreen climax forests of the Western Ghats, in Ceylon and also in Burma. In Malaysia, however, it is a common tree. The trunk is somewhat buttressed at the base and is covered with a very fibrous pale grey-brown bark; blaze with a very few drops of dirty-white milk. This white milk yields a very powerful poison which for long was in use to poison the arrows of the aboriginal tribes of the Malay Peninsula and Islands. It is reported that all the Dutch soldiers, save one, who were wounded by arrows, died. This caused the poison on the arrows to become endowed with magical properties and so, by a logical deduction, the tree also; so much so that the tree was reported to give off a poisonous exhalation which killed every living thing within a stone's throw. Birds were said to fall dead from their perch upon its branches and woe betide the weary traveller who went to sleep in its shade; he never woke up. Rumphius, who had some of the branches sent to him in a bamboo-vessel, was so carried away by what he had heard that he actually records 'so caustic were the branches sent to me in a stout bamboo-vessel that when the hand was placed on the vessel, a tingling was produced such as one feels on coming out of the cold into warmth'. It is hardly necessary to say

that most of these reports are sensational flights of fancy. Most of the exaggerated statements about this tree which were current during the seventeenth century were circulated by a Dutch surgeon named Foersch. He said that criminals who were condemned to die were offered the chance of life if they would go to the Upas tree and collect the poison, but not more than ten per cent ever returned. He further alleged that no living thing could exist within twelve miles of the tree. He instances a case of 1,600 persons, who, as the result of civil dissension, were compelled to live within this radius and 'perished to the number of 1,300 in two months'. The juice does contain two glucosides, antiarin and strychnine, which have a powerful effect upon the heart and arrest its action. The bark, as already stated, is fibrous and cloth may be made from it. The timber is white and soft and does not appear to be put to any practical use, as it is very perishable. It will possibly prove of use as a plywood.

11. *Streblus* Lour. *S. asper* Lour. is a small evergreen tree with milky juice, with a very wide distribution in waste places in India and Burma, being found in all districts except the very wet. The bark is soft, light-grey in colour, irregularly ribbed; blaze cream-coloured, turning dirty-brown and ultimately black. The wood is moderately hard and is used for making yokes. The twigs are used for cleaning the teeth and the leaves for polishing wood and ivory. The fruit is edible.

12. *Balanostreblus* Kurz. *B. ilicifolia* Kurz is a small glabrous evergreen with holly-like, glossy leaves found in the Surma Valley of Assam, southwards through Chittagong to Burma. Little is known of it.

36. URTICACEAE

Mostly herbs or shrubs with watery sap, often with stinging hairs, rarely trees; stems often containing valuable fibres; epidermal cells usually with prominent cystoliths. Leaves alternate or opposite, simple, stipulate, rarely exstipulate, often with three basal nerves. Inflorescence of sessile clusters, spikes or compact heads of flowers or flowers crowded on a common enlarged receptacle. Flowers very small, unisexual, actinomorphic. Male flowers: perianth 4-5-lobed; lobes imbricate or valvate; stamens the same number as, and opposite to the lobes; filaments inflexed in the bud; anthers 2-locular, opening by longitudinal slits; rudimentary ovary usually present. Female flowers: perianth 4-5-lobed; lobes imbricate or valvate, often enlarged in the fruit; staminodes often present, scale-like; ovary free or adnate to the perianth, sessile or on a short gynophore, 1-locular; ovule solitary, erect. Fruit an achene or a fleshy drupe; seed usually with endosperm; embryo straight.

As already mentioned this family contains a large number of herbaceous species. A few are trees, however, and a number of shrubs are worthy of attention for their fibres of economic value.

Laportea Gaud. is a genus of small deciduous trees or shrubs with stinging hairs. *L. crenulata* Gaud. is a shrub, sometimes reaching small tree-size, which is found growing gregariously in the sub-Himalayan tract from Nepal eastwards and extending into Burma. The sting of this species is so virulent that cases of prostration and high fever have been known to follow contact with it. In January when the anthers open the pollen is extremely irritating to eyes and nose. Those who have been foolish enough to use the leaves of this species as toilet-paper have not forgotten the experience in a hurry. The Nagas throw adulterous women upon a bed of it, while Naga mothers are said to find it very efficacious for keeping naughty children in order. *L. pterostigma* Wedd. is a small to middle-sized tree which is found in the foot-hills of the Himalayas in Assam. The leaves of this species also are said to possess poisonous hairs. Burkill remarks with regard to the stinging hairs: 'The stinging hairs have thin walls loaded with silica and contain a sap which acts upon the nerve-endings in the human skin. When a hair penetrates the skin, both the siliceous tip and the sap remain in the puncture and produce irritation, that due to the silica lasting a long time. What the irritant liquid is, remains uncertain, but probably, rather than being formic acid as was at one time believed, it is some albuminous poison.' The application of lime to the skin is said to be a palliative. Another remedy which is recommended is to swab the affected portion with a solution of sodium carbonate or ammonia and then to apply some kind of greasy ointment. The application of half a lemon or onion is also said to remove the irritation.

Oreocnide Miq. (*Villebrunea* Gaud.) is a small genus of large shrubs or small trees. Two species are found in India.

Leaves penninerved, entire or obscurely crenate

Leaves 3-nerved at the base, serrate ... *O. integrifolia*
... *O. frutescens*

O. integrifolia Miq. (*Villebrunea integrifolia* Gaud.) is a large shrub found in the eastern Himalayas, Assam, Burma, the Western Ghats and the Andamans. An extremely strong fibre is obtained from it which is used to make nets, cords and coarse cloth.

O. frutescens Miq. (*V. frutescens* Bl.) is also a large shrub which has a useful fibre in its bark. This species is found in Uttar Pradesh, Bihar, Bengal, Assam, and Burma.

Another genus the species of which possess valuable fibres in the bark is *Boehmeria* Jacq. The best-known of the species is perhaps *B. nivea* Gaud., Ramie Grass, Rhea Grass, which is a native of China but is cultivated to some extent in Assam, Bengal and elsewhere for its excellent fibre. It has naturalized itself in parts of Assam. The orbicular coarsely serrate leaves, 3-nerved, which are snow-white below, are very characteristic of this species.

A shrub, very similar to the last named in appearance, is *Maoutia puya* Wedd., which grows in the sub-Himalayan tract from Nepal eastwards, penetrating into the hills of north Burma. It differs from *B. nivea* in that the female flower is without a perianth.

Urtica parviflora Roxb. and *Girardinia heterophylla* Dcne. are common stinging nettles of the Himalayas. The latter is also found in peninsular India.

37. CANNABINACEAE

Shrubs or climbers. Leaves alternate or opposite, simple, undivided or palmately lobed, stipulate. Inflorescence axillary, paniculate or strobilate, the female with large conspicuous persistent bracts. Flowers dioecious, actinomorphic; the male with 5-partite calyx with imbricate parts; stamens five; anthers 2-locular, opening by slits; the female flower with a calyx closely enveloping the ovary, membranous, entire. Ovary sessile, 1-locular; style central 2-partite; ovule solitary, pendulous. Fruit an achene enveloped in the persistent perianth. Seed with a copious fleshy endosperm; embryo straight.

Cannabis sativa Linn., Hemp, Bhang, is a tall, erect, annual which is common all over India in waste places. The fibres of the bast are used for making rope. The drugs, Bhang, Ganja and Charas are prepared from resinous exudations of the stem, young leaves and flowers. Bhang consists of the dried leaves and flowering shoots. It is mixed with water and used as a beverage. Ganja consists of the dried flowering tops of cultivated female plants which become coated with a resinous substance because they have been deprived of the opportunity of setting seed by the early removal of the male plants. Charas is the resinous substance which appears spontaneously on all parts of the hemp plant when cultivated in cold and dry countries. It is used for smoking and as it contains a larger proportion of the active principle, it is more narcotic than either Ganja or Bhang (Parker).

A greenish-yellow oil may be expressed from the seeds of *Cannabis* which has good drying properties, and is used as a substitute for linseed oil. This genus, with *Humulus* Linn., the Hop, was formerly included in the family *Urticaceae*.

19. BIXALES

Small trees ; flowers hermaphrodite, actinomorphic ; sepals and petals five, or the latter absent ; ovary superior with parietal placentation ; stamens numerous to few ; anthers horseshoe-shaped ; embryo small ; endosperm copious.

38. BIXACEAE 39. COCHLOSPERMACEAE
40. FLACOURTIACEAE (incl. SAMYDACEAE)

38. BIXACEAE

Trees or shrubs with coloured juice. Leaves alternate, simple, stipulate. Flowers arranged in panicles, medium-sized, yellow, handsome. Sepals five, imbricate, deciduous. Petals five, large, imbricate, without a scale at the base. Disk absent. Stamens numerous, hypogynous, with free filaments. Anthers horseshoe-shaped, opening by short slits at the top. Ovary superior, 1-locular, with two parietal placentas. Fruit a densely echinate-setose capsule, 2-valved; valves thick with the placentas in the middle. Seeds numerous with a copious endosperm and large embryo.

Bixa orellana Linn., the source of Arnotto or Anatto Dye, has long been naturalized and cultivated in India. It is a much-branched shrub with horizontal leaves, which when crushed have a fetid smell. The flowers, 1-2 in. in diameter, are pink or white and are very handsome. The capsule is reddish-brown in colour and is covered with soft prickles. The yellow dye, for which the plant is famous, is obtained from the coloured coat of the seeds. The dye is soluble in water and is obtained by evaporating a concentrated solution. It is, however, not fast and its use as a stain for dying cloth is slowly being abandoned. It still finds a use, however, for colouring cheese and butter.

39. COCHLOSPERMACEAE

Trees with coloured juice. Leaves palmately 5-lobed, petiolate, stipulate. Flowers large, yellow, showy, arranged in large sub-corymbose panicles. Sepals five, unequal, elliptic, concave, silky outside, imbricate, deciduous. Petals five, obovate, imbricate or somewhat contorted. Stamens numerous, inserted on the disk. Anthers oblong, opening by pores or short terminal slits. Ovary 1-locular, with parietal placentas projecting into the cavity. Ovules numerous. Fruit a 3-5-valved capsule. Seeds reniform, covered with copious silky wool.

This family was formerly included in the *Bixaceae*; it contains *Cochlospermum*, a genus which is represented in India. *Cochlospermum religiosum* (Linn.) Alston (*C. gossypium* DC.), the Yellow Silk-Cotton tree, is a small deciduous tree about 18 ft. tall, with soft wood and a smooth ash-coloured bark. It is found in India in dry hilly country in central India, the Indian

Peninsula, Bundelkhand and in the dry regions of Burma. It is also frequently planted elsewhere near temples. It deserves wide popularity on account of its lovely large yellow flowers, which are produced when the trees are leafless. The bark yields a clear gum, Kuteera, which is much used by Indian cobblers. The capsule, which is somewhat like that of the Silk-Cotton tree, contains the reniform seeds embedded in floss. The floss can be used for the same purposes as Kapauk.

40. FLACOURTIACEAE (incl. SAMYDACEAE)

Trees or shrubs. Leaves simple, alternate, often 2-ranked, thick, leathery, evergreen occasionally with translucent dots and dashes; stipules present but rapidly caducous or absent. Inflorescence of solitary or fasciculate axillary flowers, hermaphrodite, monoecious, often dioecious or polygamous. Sepals usually 4-5 (2-15), sometimes similar to the petals, free, imbricate, valvate or open in the bud. Petals sometimes arranged irregularly in relation to the sepals, large, small or absent, imbricate, often with scales at the base, occasionally with a pubescent gland at the base (*Hydnocarpus kurzii*). Stamens definite or indefinite, hypogynous, free, sometimes eight, with a pentamerous calyx, often solitary opposite the petals; anthers 2-locular, sometimes short, opening by slits; filaments free or connate at the base, 1-locular, with 1-several parietal placentas; ovules two or more on 2-5 parietal placentas; styles and stigmas as many as the placentas or only one. Fruit a loculicidal capsule, berry or drupe, often large, indehiscent, sometimes edible. Seeds with a moderately large embryo and fleshy endosperm.

This family, in the days of Bentham and Hooker, was included as a tribe of the family *Bixaceae*. It was given full family rank by Engler, and Dr Hutchinson now includes the former family *Samydaceae* in it. The reconstituted family is an important one and contains several species which are forest trees and others which yield valuable drugs.

Key to the genera of *Flacourtiaceae*

Fruit a berry or drupe:

Fruit large, globose:

Fruit borne on branches ... 1. *Hydnocarpus*

Fruit borne on trunk ... 2. *Gynocardia*

Fruit small; spiny trees or shrubs:

Flowers bisexual; petals 4-6 ... 3. *Scolopia*

Flowers dioecious; petals 0:

Leaves coriaceous, lanceolate or oblong-lanceolate

4. *Xylosma*

Leaves membranous, often obovate, two lowest pairs of secondary nerves, proceeding from the base

5. *Flacourtia*

Fruit a capsule:

- | | | |
|--|-----|--------------------|
| Petals present; flowers in axillary or sub-terminal, sometimes panicled, racemes | ... | 6. <i>Homalium</i> |
| Petals absent; flowers in axillary fascicles | | 7. <i>Casearia</i> |

1. *Hydnocarpus* Gaertn. This dioecious genus is of importance because the fruits of one species are the source of an oil, known as Chaulmugra oil, which is largely used in the treatment of leprosy. It has been shown that Chaulmugra oil contains the glycerides of two optically active fatty acids, which are the active principles used in the treatment of leprosy. These two acids are to be found in the seeds of most of the species of *Hydnocarpus* though often in only negligible quantities. For the treatment of leprosy the ethyl-ester of the total fatty acid content or its combination with iodine is used for injection. To obtain the Chaulmugra oil the seeds are separated from the pulp and arillus, peeled and dried in the sun, after which they are cut up and put through a hydraulic press. Hermann Sleumer of Berlin has published a monograph of the genus,¹ in which he discusses the species, their distribution and characteristics. Incidentally, it may be mentioned that the Chaulmugra tree of Assam, *Taraktogenos kurzii* King, is now known as *Hydnocarpus kurzii* (King) Warburg. About sixteen species are found in India and Burma and a solitary one in the Andamans. They are all small to medium-sized evergreen trees with characteristic alternate leaves and large globular fruits, often as large as an orange. The species are confined to the evergreen climax forests where, although not forming societies, they are often frequent as an understorey. This is a point to remember when raising plantations of the species.

Other Indian and Burmese species which contain the Chaulmugra acid are *H. alpina* Wight, *H. laurifolia* (Denn.) Sleumer (formerly known as *H. wightiana* Bl.), *H. venenata* Gaertn., *H. dawnensis* Park. et Fisch., *H. verrucosa* Park. et Fisch., *H. cotandra* Thw. and *H. macrocarpa* (Bedd.) Warb. This leaves *H. castanea* as the only species without it. The seeds of *H. venenata* Gaertn. are highly poisonous and are used to intoxicate fish. Despite this effect, however, fish and prawns will eat the decaying seeds of the species and, since the poisonous principle seems to be communicated to the flesh, the consumption of fish and prawns by human beings at certain times of the year may be positively dangerous.

2. *Gynocardia odorata* R. Br., a common tree in Assam, growing in moist or swampy places, has a similar fruit to that of *Hydnocarpus kurzii*, but it is much inferior to it in medicinal

¹ Monographie der Gattung *Hydnocarpus* Gärtner, *Botanische Jahrbücher* (1938), Band 69, Heft 1.

value and, as may be suspected, it is often used to adulterate the true *Chaulmugra*. In *Gynocardia* the globular fruits are produced on the stem while in *Hydnocarpus* the fruits are produced on the branches.

3. *Scolopia* Schreb. A species of this genus, *S. crenata* Clos., is common in the evergreen forests of the Western Ghats. It is armed with straight spines when young.

4. *Xylosma* Forster. A small genus of evergreen species with crenate leaves which are mainly found in the evergreen forests of eastern India and also in the sub-Himalayan tracts of northern India.

5. *Flacourtia* Commers. This genus is of little importance in the forest. It is of interest because of the compound branched spines which are found upon the trunks and branches of some species. Two species, *F. cataphracta* Roxb. and *F. ramontchi* L'Hérit., are common all over India, usually wild, but sometimes cultivated for their pleasantly acid fruits. The latter species is found in the drier parts of India.

6. *Homalium* Jacq. There are about eight species of *Homalium* in India.

The following is a key to the more important species.

Stamens solitary opposite each petal:

Flowers 0.08 in. across, glabrous ... *H. minutiflorum*

Flowers more than 0.08 in. across:

Racemes simple:

Leaves obovate, obtuse or emarginate, tomentose beneath, repand-crenate ... *H. tomentosum*

Leaves elliptic, abruptly acuminate at the apex, glabrous beneath, coarsely crenate ... *H. zeylanicum*

Racemes paniculate ... *H. nepalense*

Stamens in fascicles opposite each petal ... *H. travancoricum*

Of the species mentioned in this key *H. tomentosum* Benth. is the only one of any importance from the forester's point of view. Like all the species of *Homalium* it has a very light-coloured bark. This deciduous tree is found in the deciduous forests of Burma, southern Bengal, and also in Ganjam according to Gamble. It is often to be found planted for ornament in other parts of India. It attains very large dimensions in its own home and can reach a height of 120 ft. The wood is tough and elastic and is useful for a variety of purposes.

H. zeylanicum Benth., a large evergreen tree of the Western Ghats, is common, according to Gamble, on old coffee estates. The young leaves are bright-red and the flowers fragrant. The wood is hard but does not appear to be used to any extent.

H. travancoricum Bedd. is a tree reaching 40 ft. in height with

greenish-white flowers. It is found in Travancore and Tinnevely.

7. *Casearia* Jacq., a genus of small evergreen or deciduous trees, which are common in the evergreen forests of eastern and western India. The flowers are minute and arranged in axillary fascicles. The fruit is a succulent, usually yellow, capsule, containing seeds enveloped in a scarlet (rarely orange) aril. If a leaf of a species of this genus be held to the light, translucent dashes and dots become visible, a useful method of recognizing species of this genus in the field. This characteristic is obscure in dry leaves, but boiling restores the translucency. The leaves of one species, in addition to having the translucent streaks and dots referred to above, turn the colour of dried blood when old. This species is *C. glomerata* Roxb., common in eastern India and Burma. *C. rubescens* Dalz., a tree of the Western Ghats, has leaves with a red petiole and midrib.

20. THYMELAEALES

Shrubs or trees; flowers hermaphrodite or dioecious; calyx corolline; carpel one; ovules few to solitary; stamens 1 - many; embryo straight; endosperm copious or absent.

41. THYMELAEACEAE 42. NYCTAGINACEAE

41. THYMELAEACEAE

Trees or shrubs, often with very tough bast in the bark. Leaves alternate or opposite, simple, entire, often small, exstipulate. Inflorescence of terminal bracteate or ebracteate globose heads, spikes or racemes, rarely of solitary flowers. Flowers hermaphrodite or dioecious, actinomorphic. Calyx gamosepalous, tubular, often petaloid, 4-5-lobed; lobes imbricate. Petals absent or scale-like, inserted at the mouth of the calyx-tube; scales, if present, 4-12. Stamens as many as the calyx-lobes and opposite to them, or twice as many and then the second row alternate; anthers 2-locular, introrse, opening by longitudinal slits; filaments short. Disk usually present, hypogynous, annular, cupular or of separate scales, sometimes absent. Ovary superior, 1-2-locular, entire; style in the 1-locular ovary often excentric; stigma more or less capitate; ovule solitary in each loculus, pendulous. Fruit usually indehiscent with one seed. Seed with copious or no endosperm; embryo straight.

This family does not contain any timber-trees, but several of the species are of value for certain minor forest products which can be obtained from them. The flowers of some species are fragrant and handsome.

Key to the genera

Perianth lobes 5:

Leaves alternate; flowers umbellate ... 1. *Aquilaria*

Leaves opposite; flowers in compound cymes ... 2. *Linostoma*

Perianth lobes 4:

Leaves alternate:

Flowers golden-yellow ... 3. *Edgeworthia*

Flowers white or lilac ... 4. *Daphne*

Leaves generally opposite ... 5. *Wikstroemia*

Leaves opposite or scattered; flowers in dense terminal heads ... 6. *Lasiosiphon*

1. *Aquilaria* Lam. *A. agallocha* Roxb. is a tall evergreen tree common in Assam and Burma, where it flourishes on the low hills bordering the plains. This tree is the source of the valuable commodity sold as Aloe, Eagle or Agar Wood. The timber of the species is somewhat scented and can be used for incense, but it is of no other value. Certain trees, however, become diseased and portions of the wood become infiltrated with a resinous substance. It is this diseased wood which is so valuable. Professor S. R. Bose of Calcutta has investigated this disease and eventually isolated a fungus which belongs to the group *fungi imperfecti*. Experiments are continuing in the hope that it will eventually become possible to inoculate healthy trees with the fungus in order to produce the valuable wood which is used as an incense. Another species, *A. khasiana* H. Hallier, a shrub or small tree, has been described from the Khasi Hills.

2. *Linostoma* Wall. One species of this genus, *L. decandrum* Wall., is common in the forests of Assam. It is an evergreen climbing shrub with greenish-white fragrant flowers. The bark contains a deadly poison and is much used by the Nagas to kill fish. In contrast to other fish poisons, this creeper actually kills all the fish in a river and its use is prohibited.

3. *Edgeworthia* Meissn. There are two species of this genus found in north-east India. One, *E. gardneri* Meissn., is found in the hills of Assam, Manipur and Burma, while *E. chrysantha* Lindl., is found on Saramethi between Assam and Burma. The golden-yellow fragrant balls of flowers are very handsome. A paper can be made from the bark of these species.

4. *Daphne* Linn. This is a genus of evergreen shrubs with pretty, white or lilac, often fragrant flowers in heads. The fruits are either red or orange drupes. The species are mostly found in the hill-forests and have a reputation for the strength of the fibrous bark. Moreover the bark can be made into a strong paper which is much used by the Tibetans for their sacred books.

5. *Wikstroemia* Endl. This small genus is represented in India by *W. canescens* Meissn., and by *W. indica* C.A. Mez in Burma.

They are small shrubs with yellow flowers found in openings in hill-forests.

6. *Lasiosiphon* Fresen. *L. eriocephalus* Dcne., a shrub or small tree with a 5-lobed, yellow corolla, is common in western India. At first sight the plant is often confused with one of the *Compositae*. It is a fish poison and a medicinal plant.

42. NYCTAGINACEAE

Herbs, shrubs or trees, sometimes climbing. Leaves usually opposite, sometimes alternate (*Bougainvillea*, *Pisonia*), entire, exstipulate. Flowers hermaphrodite, polygamous or dioecious, actinomorphic, sometimes subtended by an involucre of coloured bracts, arranged in heads, cymes or umbels, which are sometimes paniced. Perianth or calyx gamophyllous, petaloid, with the tube accrescent and persistent, with a 3-5-lobed limb, plaited in the bud. Petals absent. Stamens 1 - many, involute in the bud, free or connate at the base; anthers 2-locular, opening lengthwise. Ovary superior, 1-locular. Ovary consisting of one carpel, 1-locular; ovule one, erect. Fruit a thin-walled achene. Seeds with or without endosperm.

The best-known plants of this family are undoubtedly the species of *Bougainvillea* which make such a show in Indian gardens. The so-called flowers are often a puzzle to students until they learn that the flower is really an inflorescence in which two or three true flowers, each attached to its coloured bract, are gathered into a head at the tip of the peduncle.

In the genus *Pisonia* there are two common species, *P. aculeata* Linn. and *P. excelsa* Bl. The former, a thorny shrub, occurs gregariously along the shores of the Andamans and adjoining coasts of India and Burma. In appearance it is rather like *Clerodendron inerme* Gaertn., with which it often associates. The latter, *P. excelsa* Bl., is an unarmed, medium-sized, evergreen tree with fruits which are covered with an extremely sticky substance.

21. PROTEALES

Trees or shrubs; flowers hermaphrodite, monoecious or dioecious; calyx corolline; ovary 1-locular; ovules one or more; stamens four, opposite the calyx-lobes; embryo straight; endosperm absent.

43. PROTEACEAE

Trees or shrubs. Leaves alternate, simple or pinnatifid, exstipulate. Inflorescence of pairs of flowers arranged in axillary racemes, or in fascicles. Flowers hermaphrodite, actinomorphic or zygomorphic. Calyx petaloid, 4-lobed; lobes valvate, usually tubular in the bud, coloured. Petals absent. Stamens

four, opposite the calyx-lobes; filaments inserted on the calyx-lobes; anthers 2-locular, opening introrsely by longitudinal slits. Ovary sessile or stipitate, with or without hypogynous scales or disk at the base, 1-locular; ovules one or more, pendulous or laterally attached. Fruit a hard globose nut or a leathery follicle.

This family is chiefly found in Australia and South Africa. There is, however, one genus, *Helicia* Lour., indigenous to India, while one or two others, notably *Grevillea* R. Br., have been introduced.

Helicia Lour. contains several small trees and shrubs which are found in the evergreen forests of India and Burma. The flowers are arranged in pairs on a central axis making up a short raceme. The lobes of the perianth are revolute. The fruit is a subglobose hard nut. Some of the species reach a large size, notably *H. javanica* Bl. (*H. robusta* Wall.), but little is known of the timber of these species.

Grevillea R. Br. *G. robusta* A. Cunn. has been introduced into India from Australia and has been extensively cultivated. The wood has an exceedingly pretty grain, but although one sees it everywhere as an avenue tree it has little to recommend it for this purpose. It is extremely brittle and suffers much damage in the violent storms of India and becomes very unsightly.

Hakea Schrad., another Australian genus with acicular leaves, is sometimes met with in gardens. The species most frequently planted is *H. acicularis* Knight.

22. PITTOSPORALES

Small trees or shrubs; flowers hermaphrodite, actinomorphic, hypogynous; sepals and petals five; ovary superior, 2-5-locular; stamens five, alternate with petals; embryo minute; endosperm copious.

44. PITTOSPORACEAE

Trees or shrubs. Leaves simple, alternate or almost whorled at the ends of the branches, exstipulate. Flowers hermaphrodite, corymbose or umbellate, sometimes in dense terminal panicles. Sepals five, imbricate. Petals erect, in fives, clawed, with the claws more or less connivent. Stamens five, alternate with the petals, hypogynous. Anthers versatile, 2-locular. Ovary of two, rarely 3-5 carpels, 1-locular or 2-5-locular by the intrusion of the parietal placentas. Style simple. Ovules many. Fruit a capsule or berry. Seeds often embedded in a sticky pulp. Embryo very minute with copious endosperm.

A small family of which the species are mainly Australian. About eight species are indigenous in India but none of them is of any account in forestry. They all have rather pretty yellow flowers. The shrub hitherto known as *Pittosporum floribundum* Wight. et Arn., a common shrub of the Himalayas and the hills of peninsular India, should be correctly called *P. nepaulense* (DC.) Rehder et Wilson.

23. CAPPARIDALES

Trees or shrubs ; flowers hermaphrodite, somewhat zygomorphic ; ovary on a long gynophore or stipitate ; stamens numerous to few ; embryo curved ; endosperm scanty or absent.

45. CAPPARIDACEAE 46. MORINGACEAE

45. CAPPARIDACEAE

Herbs, shrubs or trees, erect or climbing. Leaves alternate, simple or digitate, exstipulate or with minute spiny stipules. Flowers hermaphrodite, usually tetramerous, mostly zygomorphic, rarely quite regular, variously arranged, often in vertical lines above the axils. Sepals four, free or united, imbricate or valvate. Petals usually four, free, imbricate or open in the bud, rarely valvate. Stamens 4 - many, usually exserted, some without anthers. Disk absent or tumid or lining the calyx-tube. Ovary 1-locular, usually on a gynophore. Ovules numerous, on 2-4 parietal placentas. Fruit a berry, sometimes elongate and twisted, torulose or globose. Seeds usually reniform or angular, without endosperm.

The family is readily recognized on account of the long gynophore which juts out beyond the stamens and carries the ovary. A large number of shrubby species of *Capparis* Linn., usually with large white or pale-yellow flowers and purple anthers, are found in our forests. The stipules are spines in this genus. Many of the species are worthy of cultivation in gardens. One remarkable species which is exceedingly common in scrub forest in the drier parts of India is *C. aphylla* Roth, which, with *Salvadora oleoides* and *Prosopis spicigera*, forms the bulk of the *rakk* vegetation. As the name implies, this species is leafless, or almost so, and the function of the leaves is taken over by the green bark of the branches which is extremely rich in chlorophyll. Reproduction in this plant is almost entirely by means of root-suckers. It does not grow above 20 ft. in height but can reach a girth of 8 ft. (Parker).

One tree species is found in the plains of India and in Madras State. This is *Crataeva unilocularis* Ham., a deci-

duous tree with digitately trifoliate leaves, cream, yellow or purple flowers and a globose fruit, the size of a golf ball, suspended by the enlarged woody gynophore. The seeds are horseshoe-shaped. The flowers are very handsome and are arranged in terminal corymbs. The bark of the tree is grey and is covered with horizontal wrinkles.

Gynandropsis gynandra Briq., a herbaceous species with pale-purple flowers, is very common in certain areas of the plains in Assam and Bengal.

46. MORINGACEAE

Soft-wooded deciduous trees with corky bark. Leaves opposite, impari-, bi- or tripinnate, with opposite pinnae and leaflets, with glands at the base of the petiole and pinnae, exstipulate. Flowers fragrant, zygomorphic, hermaphrodite, arranged in large axillary panicles. Calyx cup-shaped with five unequal, spreading or reflexed imbricate lobes. Petals five, the upper two the smaller. Disk lining the calyx-tube. Stamens inserted on the edge of the disk, declinate, five perfect opposite the petals; with five (or seven) reduced to the filaments; anthers dorsifixed, 1-locular, opening by slits. Ovary stipitate, 1-locular; ovulus numerous, biseriate, on three parietal placentas, anatropous. Fruit a long beaked, 6-9-angled, torulose capsule, pendulous, 3-valved. Seeds 3-winged, without endosperm.

Moringa oleifera Lamk. (*M. pterygosperma* Gaertn.), the Horse-radish tree. This deciduous tree, with corky bark, widespread in India, receives its trivial name from the fact that the freshly scraped young roots furnish a surprisingly good substitute for the true horse-radish, which incidentally is the root of *Cochlearia amoracia* Linn. The tripinnate, somewhat fern-like foliage, its honey-scented white flowers and its pendulous bean-like fruits over 1 ft. long, readily distinguish this small tree. Parts of it can be put to a surprising variety of uses. The leaves, flowers and young fruits can be eaten as a vegetable, the young fruits being especially rich in Vitamin C. The seeds yield an oil, known as Ben Oil, and this is valued by watch-makers. Camels eat the lopped boughs with avidity. A gum is obtained from the bark. All parts of the plant are used in indigenous medicine, the number of ailments which are said to be cured or relieved, ranging from skin complaints and beri-beri to catarrh and syphilis. An application of the bark to the foreheads of elephants is said 'to make them sagacious' (Burkill). The wood is absolutely useless as it rots away in a few months. The tree can be readily propagated by means of cuttings. A close relative, *M. concanensis* Nimmo, is found in Madras State on the dry hills of the Konkan; it has reddish-yellow flowers.

24. TAMARICALES

Shrubs or small trees; flowers hermaphrodite, actinomorphic; ovary superior, 1-locular, with parietal or basal placentas; stamens 5-10; embryo straight; endosperm present or absent.

47. TAMARICACEAE

This family is composed of small trees, shrubs or perennial herbs. The leaves are alternate, scale-like, small, narrow, sessile, with a broad base, rather fleshy, entire, often gland-dotted, usually glaucous, exstipulate. Inflorescence of solitary flowers or of terminal catkin-like racemes or spikes or panicles. Flowers regular, usually hermaphrodite to hypogynous. Sepals free, persistent, 4-5 in number, imbricate and sometimes connate at the base. Petals five, inserted on the receptacle, imbricate in the bud, marcescent. Stamens equal in number to, and alternate with, the petals, or twice as many, inserted on the edge of an annular glandular disk; filaments free at the base or united into a ring, cup or tube; anthers 2-locular, opening by longitudinal slits, introrse, dorsifixed. Ovary sessile in the disk, trigonous, 1-locular; placentas parietal or basal; styles as many as the placentas, free or united at the base; ovules numerous, ascending. Fruit a capsule, 1-locular. Seeds numerous, with or without endosperm, bearded at the apex or enveloped in hairs. Embryo straight.

This small family contains four genera and about one hundred species.

Two genera of this family, *Tamarix* and *Myricaria*, the former with five stamens, the latter with ten, occur in India, but the former is the only one of importance.

Tamarix Linn. There are six species of this genus in India, most of them confined to the north-western regions.

The following is a key of the commoner species.

- Twigs articulate; bracts sheathing ... *T. articulata*
- Twigs not articulate, bracts not sheathing:
 - Bracts as long as the flower or nearly so:
 - Leaves sheathing with a broad white margin ... *T. dioica*
 - Leaves strongly impressed-punctate ... *T. salina*
 - Bracts shorter than the flowers ... *T. troupinii*

These species seem to flourish in regions of scanty rainfall accompanied by extremes of temperature. They are especially fond of alluvial soil when the water table is not too low. In such places *T. troupinii* Hole and *T. dioica* Roxb. grow profusely accompanied by a thick growth of *Saccharum spontaneum* and are thus of value in arresting erosion. *T. articulata* Vahl is one of the very few trees which can thrive on saline soil. It gives a wood much valued in the Punjab plains for making ploughs, Persian wheels, ornaments and fuel. This tree coppices well.

25. VIOLALES

Small trees, shrubs or herbs; flowers hermaphrodite, zygomorphic; sepals and petals five, the latter unequal; ovary 1-locular with 3-5-parietal placentas; stamens five; embryo straight; endosperm copious.

48. VIOLACEAE

Trees or shrubs in India as well as herbaceous perennials. Leaves alternate, simple, stipulate; stipules often leafy or rigid. Flowers regular or zygomorphic, hermaphrodite, rarely polygamous. Sepals five, persistent, imbricate. Petals five, mostly unequal, imbricate or contorted, the lowest often larger and spurred. Stamens five, inserted on the edge of the disk or within it, the abaxial stamen often spurred at the base. Ovary free, sessile, 1-locular with 3-5 parietal placentas. Ovules anatropous, 1-2 on each placenta. Fruit a 3-valved capsule or baccate. Seeds with a fleshy endosperm.

Many species of this family are favourite garden-plants but there is one genus in India which reaches small tree size. This is the genus *Rinorea* Aubl., which has regular flowers, as different from those of the violet as it is possible to imagine. The commonest species is *Rinorea bengalensis* O. Ktze. (*Alsodeia bengalensis* Wall.). Several other species are found in other parts of India.

26. POLYGALALES

Shrubs or herbs; flowers hermaphrodite, zygomorphic; sepals and petals five; ovary 1-3-5-locular; stamens eight, monadelphous to beyond middle; embryo straight; endosperm present.

49. POLYGALACEAE

Herbs, trees, erect or climbing shrubs. Leaves alternate, simple, quite entire, exstipulate. Flowers hermaphrodite, zygomorphic, 3-bracteate, arranged often in terminal panicles; pedicels often articulated. Sepals five, of which the two inner are the largest and are often petaloid, wing-like. Petals 3-5, hypogynous; outer two free or adnate to the lowest, sometimes crested, often keeled. Stamens eight, with the filaments usually united into a sheath which is split above, and often united to the petals. Anthers opening by an apical pore. Ovary 1-3-locular with one pendulous ovule in each loculus. Seeds with or without arillus. Fruits drupaceous or winged.

At first sight the flowers of *Polygalaceae* are apt to be confused with those of the *Papilionaceae*. A little consideration should be quite sufficient to obviate such a mistake. There are three woody genera of this small family in India, which, although of

no importance in forestry, may be met with in the forests.

- | | | |
|---|-----|-------------------------|
| Climber, fruit a winged seed | ... | 1. <i>Securidaca</i> |
| Shrubs or trees with yellow flowers; fruit a drupe; seeds without arillus | ... | 2. <i>Xanthophyllum</i> |
| Shrubs with yellow and purple, or white and lilac flowers; seeds with a conspicuous arillus | ... | 3. <i>Polygala</i> |

1. *Securidaca* Linn. *S. tavoyana* Wall. is a large woody climber, found in Assam, Chittagong and Burma. The fruit is quite distinctive, being 1-seeded, indehiscent, with a long coriaceous wing at the upper end.

2. *Xanthophyllum* Roxb. There are about five species of this genus in India, Burma and the Andamans. As implied in the generic name the leaves turn yellow on drying, being similar to those of *Symplocos* in this respect.

3. *Polygala* Linn. The vast majority of the species of this genus are herbs, but two shrubs are found in the hill-forests of India and Burma. *P. arillata* Ham. is found in the eastern Himalayas, Khasi and Naga Hills and the mountainous parts of Burma. The purple and yellow flowers in pendulous panicles and the seed with its conspicuous yellow arillus are very striking. *P. karenium* Kurz, found in the Karenni Hills, has white flowers, the petals of which are tipped with lilac.

27. PASSIFLORALES

Herbaceous climbers; flowers hermaphrodite, actinomorphic, coronate; ovary on a gynophore, 1-locular; stamens five or more; embryo straight, large; endosperm fleshy.

50. PASSIFLORACEAE

Herbaceous plants, climbing by means of tendrils. Leaves alternate, simple, entire or lobed in various ways, often with glands on the petiole. Flowers actinomorphic, hermaphrodite or polygamous, usually solitary in the axil of a leaf. Sepals five, imbricate, persistent, free or partially united. Petals five, free or variously united, often coloured. Corona of one or more rows of thread-like filaments or scales, or annular. Stamens five or more; anthers 2-locular, opening lengthwise. Ovary stipitate upon a gynophore, 1-locular, with normally three parietal placentas; ovules numerous. Fruit a globose indehiscent berry. Seeds with endosperm; embryo straight.

The genus *Passiflora* Linn., although mainly American, is represented in our forests by a number of twiners. The species are of no account to the forester but the strange flowers, which are often handsomely coloured, invariably attract attention. These climbers are collectively known under the trivial name

of Passion Flower, which can be ascribed to the belief that the various parts of the flowers can be correlated with the implements of the crucifixion in Christian belief. The principal value of these plants is in the garden, for, apart from their odd flowers, which are often brightly coloured, some of the species have an edible fruit of very delicate flavour.

28. CUCURBITALES

Trees or herbs, twining or erect ; flowers actinomorphic or zygomorphic ; monoecious or dioecious, epigynous ; ovary inferior ; stamens numerous to few ; embryo straight ; endosperm scanty or absent.

51. DATISCACEAE 52. CARICACEAE

51. DATISCACEAE

Trees or herbs. Leaves alternate, imparipinnate or simple and then palminerved, exstipulate. Inflorescence of racemes or panicles. Flowers dioecious, actinomorphic, small. Male flower; calyx gamosepalous, 3-9-fid; lobes short; petals absent; stamens 4-25, when equal in number to the calyx-lobes, then opposite to the lobes; anthers 2-locular, opening by longitudinal slits; filaments often short ; rudimentary ovary small or absent. Female flowers; calyx-tube adnate to the ovary, 3-9-fid; lobes short; petals absent; stamens rudimentary; ovary 1-locular; ovules numerous, anatropous on parietal placentae; styles free, simple or branched. Fruit a capsule crowned by the calyx-lobes and styles, opening at the summit. Seeds very numerous, small; endosperm scanty; embryo cylindrical.

This small family is represented in India by two genera and two species only. *Datisca cannabina* Linn. is a herb found in the foot-hills of the Himalayas. *Tetrameles nudiflora* R. Br. is an enormous deciduous tree found in Bengal, Assam, Burma and the Western Ghats.

Tetrameles nudiflora R. Br. is typically tetramerous with 4-lobed calyx, four stamens, and ovary with four parietal placentas. This deciduous tree may reach a height of 154 ft. and towers high above the canopy of the evergreen forest of which it is a member. It has enormous plank-buttresses and a leaden-grey-coloured shining bark which is quite unmistakable. The blaze is yellowish. The rate of growth is extremely rapid and this explains how it is found in dense evergreen forest. The seeds are minute and, being shed from an enormous height, achieve a very wide distribution. Hence any accidental opening in the evergreen canopy, consequent upon the death of a dominant, leaves a way open to the seed of this species. Its extremely rapid growth takes it up to the canopy before the gap can close over. The small flowers, which appear when

the tree is leafless, are much frequented by bees, which often make their nests in the trees. Nearly all the large trees of this species seen in Bombay State carry an enormous number of bees' nests, but it is not usual to see this tree festooned with nests in eastern India. The wood is rather soft and is not durable. Notwithstanding this, dugouts are frequently made from the tree in Assam, and moreover the timber is useful for plywood and match-sticks. It is a favourite tree for the woodpecker to nest in, as the wood is soft and can easily be hollowed out to take the nest. Certain trees have been observed in which a colony of these birds have built a series of nests in holes in the trunk arranged in a vertical line. It is also one of the trees selected by the hornbill to nest in.

52. CARICACEAE

Small trees with milky juice. Leaves alternate, deciduous, leaving large scars, arranged in a cluster at the top of the tree, palmatifid, on long hollow petioles. Flowers polygamous, dioecious or rarely hermaphrodite, arranged in long or short axillary panicles. Male flowers: calyx 5-lobed, small; petals united into a slender tube, 5-lobed; lobes contorted or valvate; stamens ten, inserted in the corolla; anthers 2-locular, opening lengthwise. Female flowers; calyx as in the male; petals five, free; ovary superior, sessile, 1-locular; ovules numerous, attached to five parietal placentas. Fruit an indehiscent pulpy berry. Seeds with a pulpy outer skin and an inner harder layer, without endosperm.

Carica papaya Linn. This herbaceous tree with a white latex is a native of tropical America and was introduced into India at an early date. The fruit is delicious and some very fine seedless varieties have been produced. An enzyme, papain, found in the latex, is similar in action to pepsin and is used in digestive troubles. Meat is made more tender by wrapping it in the leaves of this species. The stem and the pith can be eaten.

29. CACTALES

Succulent trees, herbs or shrubs, sometimes climbing; flowers hermaphrodite, actinomorphic; ovary inferior with 1-3 parietal placentas; stamens numerous; embryo straight or semi-circular; endosperm usually absent.

53. CACTACEAE

Succulent herbs or shrubs, sometimes arborescent. Leaves very much reduced, if present (*Pereskia*) fleshy, normal and alternate. Flowers hermaphrodite, actinomorphic, solitary, axillary or terminal, usually large and showy, seated on special tubercles. Calyx superior, petaloid, not always distinguishable

from the petals, which are in several series, numerous, epigynous, often increasing in size from below upwards, the upper interior, sometimes connate at the base into a tube. Stamens very many, inserted at the base of the petals and free or adnate to them; anthers 2-locular, opening lengthwise. Ovary inferior, 1-locular, with many ovules inserted on 3 - many parietal placentas. Fruit baccate, spinous or smooth, many-seeded. Seeds with or without endosperm.

Typically, this is a tropical American family but some species have been introduced into India and have become naturalized. *Cereus hexagonus* Haw., with tall columnar stems, sharply 6-ridged, and large white solitary flowers, is common in Bihar and Orissa. The species can be separated from any of the arborescent *Euphorbias* by the absence of a milky latex.

There are three species of Prickly Pear (*Opuntia*) in India, which can be separated by the following key.

Only one large spine to each areole	...	<i>O. monacantha</i>
Several spines to each areole:		
Spines tawny-brown, or black	...	<i>O. elatior</i>
Spines pale-yellow	...	<i>O. dillenii</i>

These three species are to be found in the hotter and drier areas of India and they also grow in gardens in the damper climates. *O. monacantha* Haw. is a species which can be used as a host for the cochineal insect, and on the introduction of the latter into India the cactus was killed over large areas. This species can easily be grown from cuttings and when placed close enough forms a good impenetrable hedge. As the hedge grows older, however, gaps appear and reduce its efficiency.

Pereskia bleo DC., the Barbados Gooseberry, is often seen in gardens. It has normal leaves and pretty pink or red flowers. Other strange species of this interesting family are found in gardens, particularly epiphytic species of *Rhipsalis*, with flattened 2-edged serrate branches and white flowers.

30. TILIALES

Trees or shrubs with stellate indumentum; flowers hermaphrodite, dioecious or monoecious, actinomorphic; ovary superior; placentation axile; stamens monadelphous; anthers 2-locular, opening by slits or pores; embryo usually straight; endosperm copious or absent.

54. TILIACEAE 55. STERCULIACEAE

56. BOMBACACEAE

54. TILIACEAE

Trees or shrubs, rarely herbs. Leaves alternate, simple, penni-

nerved or palminerved, entire, lobed, crenulate or dentate, stipulate; stipules free, deciduous or persistent, sometimes absent. Inflorescence cymose, in axillary or terminal corymbs or panicles. Flowers hermaphrodite, rarely unisexual. Sepals five, valvate in the bud. Petals as many as the sepals or rarely absent, contorted, imbricate or valvate. Stamens usually numerous, more than double the number of the sepals; filaments free or shortly connate at the base into five or ten bundles, filiform; anthers 2-locular, dehiscing by a slit longitudinally or by an apical pore. Ovary superior, sessile, 2-10-locular; style simple and divided at the apex; stigmas as many as the loculi; ovules on axile placentas, one or more in each loculus, ascending or pendulous. Fruit 2-10-locular, rarely 1-locular by abortion, baccate or drupaceous, sometimes dehiscent. Seeds with thin or copious endosperm; embryo straight, cotyledons foliaceous.

This family is closely allied to *Malvaceae*. The two can be easily separated by the stamens. These are monadelphous high up in *Malvaceae*, connate only at the base in *Tiliaceae*. The latter, in common with the *Sterculiaceae*, *Bombacaceae* and *Malvaceae*, is characterized by the possession of a valvate calyx and mucilage loculi. The possession of mucilage loculi separates it from *Elaeocarpaceae* and *Flacourtiaceae*, the majority of whose species have a valvate calyx. The *Euphorbiaceae* which superficially recall (to the less critical student) some species of *Tiliaceae* are easily separated by the botanical characters of the gynaecium and structure of the inflorescence. The 2-locular anthers separate *Tiliaceae* from *Malvaceae* and *Bombacaceae* and the free stamens from *Sterculiaceae*.

This large family is well represented in India by trees and shrubs. A very large number of the shrubs are reputed to possess a fibre of great strength in the bark. The jute plants, *Corchorus capsularis* Linn. and *C. olitorius* Linn., are, of course, well known and their cultivation has assumed enormous proportions in Bengal and Assam. The cultivation requires the climate found in eastern India and if grown in other conditions the crop is a failure. The leaves of both these plants can be used as a vegetable. The seeds are poisonous.

Key to the Indian genera which reach tree size

Sepals connate into a cup	...	<i>Pentace</i>
Sepals not connate, free:		
Petals with a glandular claw:		
Fruit a drupe	....	<i>Grewia</i>
Fruit winged	... ..	<i>Colona</i> (Columbia)
Petals not clawed:		
Fruit prickly	...	<i>Echinocarpus</i>
Fruit a fleshy drupe	...	<i>Elaeocarpus</i>

Pentace Hassk. *P. burmanica* Kurz is an evergreen tree of the climax forests of Burma, which reaches an enormous size. The wood is used locally for making boats, but it is also exported to Europe and is sold as Burma mahogany. The fruit is a capsule with five papery wings much resembling the fruit of certain species of *Combretaceae*. The leaves of *Pentace* are, however, quite different from those of any *Terminalia*.

Grewia Linn. This large genus is well represented in India and Burma. Two species, *G. sapida* Roxb. and *G. sclerophylla* Roxb., are small shrubs of the grassy *terai* in Bengal, Assam and Burma. These are burned to the ground every year but send up flowering and fruiting shoots when the fires have passed over. The fruit of the former is not to be despised, in fact the fruit of a good many species of this genus is worth eating.¹ *G. disperma* Rottl. (*G. sepiaria* Roxb.) is one of the lac-bearing trees of Assam and is largely cultivated there, especially in the Garo Hills. A number of other species are common in the deciduous forests and are rarely to be found in evergreen forests. The genus is not difficult to spot in the field. The flowers are very distinctive: the flower-buds are oblong and obtuse; the sepals valvate and often coloured inside; the yellow petals usually strap-shaped with a thick claw at the base; the stamens are numerous with reddish-orange filaments; the fruit is often a lobed berry. The leaves of many species are characteristic; the margin is dentate or serrate and there are 3-5 nerves from the top of the petiole.

Colona Cav. (*Columbia* Pers.). *C. floribunda* Kurz is a small tree exceedingly common in the hills of eastern India. In Burma, Manipur and Assam it is one of the commonest trees in the secondary jungle that come up after an area has been cultivated by the hill-tribes. The leaves turn the colour of dried blood before falling. The flowers are rather like those of *Grewia*, but the yellow petals are covered with red dots.

Sloanea Linn. (*Echinocarpus* Bl.). The species of this genus, of which there are about five in India, are large trees inhabiting the evergreen climax forests (hills and plains) of eastern India. The leaves are usually large with parallel secondary nerves. The fruit is very characteristic, being globular and covered with long spines. It is very similar to the fruit of the edible chestnut, *Castanea sativa* Mill., which can be distinguished by the sharply serrate leaves.

Elaeocarpus Linn. This genus and the last named are sometimes included in a special family of their own, the *Elaeocarpaceae*, which differs from the rest of the *Tiliaceae* in not having mucilage sacs in pith, bark and leaf parenchyma.

¹ Actually *G. asiatica* Linn. is commonly cultivated in Bengal for its fruit.

The genus *Elaeocarpus* in India and Burma is a very large one and the species vary in size from small to very large trees, some of which are co-dominants in the evergreen climax forests of eastern and western India, and also in those of Burma. The oldest leaves turn red or reddish-yellow before falling and this feature is sometimes of use in recognizing this genus in the forest. It must not be imagined that the whole crown turns red or yellow, for as a rule only a few leaves change colour, but it is safe to say that every species has at least a few red leaves in the crown. The trees, being evergreen, do not shed their oldest leaves every year or even at the same time. Some species have stilt roots. *E. wallichii* Kurz and *E. varunna* Ham. exhibit this characteristic. The petals of this genus are very distinctive, being wedge- or strap-shaped with a laciniate upper third. One of the anther-loculi is often produced into a long awn. The flowers are usually white and are frequently fragrant. The fruit is a drupe with one stone. The stone is tubercled, rugose, ridged, muricate or channelled. The stones from the fruits of *E. ganitrus* Roxb. are strung upon a cord and made into necklaces which are often to be seen worn by Hindu mendicants. The fleshy part of the drupe is edible. The buds of some species of *Elaeocarpus*, e.g. *E. petiolatus* Wall. and *E. varunna* Ham., are surrounded by a drop of inflammable gum.

55. STERCULIACEAE

Trees or shrubs with soft wood, sometimes climbing perennial or annual herbs; indumentum usually stellate, less often stellate with forked or simple hairs, rarely silvery lepidote (*Heritiera*, *Pterospermum*). Leaves alternate, simple or digitately (3-9 leaflets) compound; stipules free, deciduous, rarely persistent and foliaceous. Inflorescence axillary, rarely terminal, usually cymose, often complicated. Flowers hermaphrodite or unisexual, regular or occasionally irregular (*Helicteres*). Sepals 3-5, valvate in the bud, often connate below, or free. Petals sometimes absent; if present, five, hypogynous, free or adnate by their bases to the staminal tube, contorted or imbricate in the bud. Stamens numerous (occasionally few); filaments rarely free, more usually connate into a tubular column in which the anther-bearing filaments alternate with staminodes; anthers in heads, or in a single ring, or dispersed on the outside of the tube, or arranged along the edge of a cup alternating with staminodes; anthers extrorse, of two parallel or diverging loculi, rarely confluent (*Helicteres*). Ovary free, of one or 2-5 more or less united carpels; ovules two or more in each loculus, inserted on the inner angle, ascending or horizontal, anatropous rarely orthotropous; styles as many as the loculi, free or connate. Fruit dry, rarely fleshy, often of loculicidal or indehiscent woody

capsules. Seeds without or with a thin fleshy endosperm; embryo straight or curved.

One species of the family, *Theobroma cacao* Linn., the Cocoa tree, is indigenous to South America. As far as India is concerned the family contains a large number of forest species but only one genus is of any importance from the forester's angle. This is the genus *Heritiera* Ait., of which two species, *H. fomes* Buch. and *H. littoralis* Dryand, are small deltaic trees. The former, the *Sundri* tree of Bengal, grows gregariously, covering immense areas in the delta formed by the combined Ganges and Brahmaputra rivers. The roots send up pneumatophores above the mud flats in which they grow. The timber and bark of this species are in great demand in the neighbouring city of Calcutta. In common with all the species of the genus the *Sundri* tree has leathery leaves which are covered below with silvery or silvery-rusty peltate scales. The fruits are woody boat-shaped indehiscent shining capsules with a strong keel and float on the seawater. The seeds are viable for weeks.

H. littoralis Dryand, the other species living close to the seashore, is found in Burma, the Andamans, and on the west coast of south India.

Of the inland species *H. macrophylla* Wall. occurs in Assam and extends into Manipur and Burma. *H. papilio* Bedd. is found in the evergreen forests of the Western Ghats.

Another genus, *Sterculia*¹ Linn., is very common in India and Burma but is of no consequence in forestry. One species, *Pterygota* (*Sterculia*) *alata* R. Br., is a very common ornamental tree in Dehra Dun and does very well. It is indigenous in southern and eastern India and also in Burma. The fruit of this species is a large (5 in. diameter) globose follicle. Most of the other species are readily recognized when in fruit from the bunch of red follicles which open on the ventral suture, where the seeds are also attached. *Firmiana* (*Sterculia*) *colorata* R. Br. is conspicuous by the follicle opening out flat like a leaf with the seeds remaining attached to the margins. The bark of some of the *Sterculias* has a very tough bast which can be made into strong ropes. The seeds of some species are eaten.

The wood of *Sterculia campanulata* Wall. is soft and white, and is suitable for match splints. It has, however, an unpleasant characteristic in that it gives off an evil-smelling volatile sulphur-containing oil which combines with the lead in lead paints. For this reason it is refused as a cargo by ships' officers. The oil can be driven off by boiling or by blowing air through the wood. The smell is similar to that of the wood and flowers of *S. colorata* Roxb.

¹ This genus is now split up into three: *Pterygota*, *Firmiana* and *Sterculia* proper.

Pterospermum Schreb. is a genus the species of which are often cultivated for ornament on account of their handsome foliage. *P. acerifolium* Willd. is preferred for this purpose, though several others are equally suited. The leaves are deep-green above and are either silvery or rusty-tomentose with stellate hairs below. The flowers are white, fragrant and showy with long linear-oblong petals.

Helicteres isora Linn. is one of the few species with zygomorphic flowers. The leaves are like those of the hazel, and the petals bright-red. The fruit is like a bunch of thick cords twisted and tapered to the apex. It is common in many parts of India, and is often found growing gregariously in valleys. It is a common shrub on the grass-covered hills of Madras State.

An interesting discovery, which has added another genus to the Indian flora, is the presence of the genus *Mansonia* in the evergreen forests at the foot of the Naga Hills. This gives an excellent timber which is heavier, harder and stronger than teak. Altogether a very desirable addition to the forest flora.

Kleinhovia hospita Linn. with pink flowers in ample terminal panicles, when not in flower extremely like *Hibiscus tiliaceus* in appearance, *Guazuma tomentosa* H. B. K. with yellow and purple flowers and *Abroma augusta* Linn., with large purple flowers, are cultivated as ornamental trees in many parts of India.

Dombeya spectabilis Bojer is cultivated almost everywhere in India for its beautiful white or pale-pink flowers.

56. BOMBACACEAE

Very large trees often with buttressed bases. Leaves simple or digitate, alternate, often lepidote, exstipulate or stipulate; stipules deciduous. Flowers actinomorphic, hermaphrodite, often large and showy, arranged in crowded fascicles, often on the old wood, or solitary. Calyx-tube definite with valvate lobes, persistent, often subtended by an epicalyx. Petals five, usually free, stamens numerous; filaments united into a column; anthers reniform to linear, 1-locular, opening by slits; pollen smooth. Ovary superior, 2-5-locular; style simple, capitate or lobed. Ovules two or more on the inner angle of the loculi. Fruit a capsule or fleshy, loculicidally dehiscent or the valves falling away. Seeds often embedded in hairs.

Some of the members of this family grow into colossal trees.

Three genera are found in the forests and they can easily be separated by the following key.

Flowers on the old wood	...	1. <i>Cullenia</i>
Flowers terminal:		
Flowers red	...	2. <i>Salmalia</i>
Flowers white	...	3. <i>Ceiba</i>

1. *Cullenia* Wight. *C. excelsa* Wight is a very tall tree of the Western Ghats forests. The leaves are unmistakable, being oblong or oblong-lanceolate in shape with very close parallel nerves and covered on the under-surface with silvery or orange-coloured peltate scales. The flowers are rusty-red in colour and are borne on the old wood. The fruit, a capsule covered with long spines, is characteristic.

2. *Salmalia malabarica* Schott. et Endl. (*Gossampinus malabarica* (DC.) Alston), the well-known *Simul* or Cotton tree, better known as *Bombax malabaricum* DC., is one of the largest of Indian trees. It develops enormous buttresses at the base and the silky covering of the seeds finds many uses in this country. The bright-red flowers are well known, but in parts of Assam there are trees with orange or even with yellow flowers. The tree grows well on silt and is to be found everywhere in eastern India on the banks of alluvial streams. The young stems and branches at all ages are covered with sharp stout conical prickles.

3. *Ceiba pentandra* Gaertn. (*Eriodendron anfractuosum* DC.) is a very large deciduous glabrous tree with whorled branches, very similar in appearance to *Salmalia malabarica*. The flowers, however, are smaller than in that species and moreover are dirty-white in colour with a milky smell. The tree is indigenous in the Andamans, Burma and southwards but is often to be found planted in India. The cotton from the capsule is used for stuffing pillows, cushions etc. The ease with which cuttings strike has led to the extensive use of this species as a hedge in Malaya.

A number of species of the *Bombacaceae* have been introduced into India and are cultivated for their fruits or for other desirable qualities.

Among these may be mentioned *Ochroma lagopus* Sw., the *Balsa* wood, which is valued for its fantastically light wood which only weighs about 7 lb. per cubic foot. Combined with lightness it has also very great strength and it is this combination of qualities which makes it an important species.

Durio zibethinus Linn. is the well-known fruit tree *Durian*, of Burma and Malaya. Incidentally the specific name is derived from the Italian *Zibetto* or Civet Cat, an animal which smells so strongly that its mere presence on the landscape is an offence to the nostrils. This name has reference to the stench given off by the fruit, which is so offensive, that some people cannot bring themselves to eat it. Those whose noses are made of coarser clay aver that the flavour of the fruit is beyond compare. Certain it is that lovers of the fruit make expeditions to eat it, for owing to rapid chemical decomposition which takes place in the ripe fruit, it is not possible to transport it any considerable distance. All the animals of the jungle are said to

be attracted by the mephitic odours of the ripe fruit. The flowers are white, cream or red.

Adansonia digitata Linn. is the *Baobab*, a large tree with a bottle-shaped trunk. It is indigenous in Africa but has been introduced into India and is occasionally to be found planted. The leaves are very similar to those of *Salmalia*. The flowers are very large, 6-7 in. in diameter, pure white, and are found pendulous at the end of long peduncles. The stamens form a large globose head at the top of the staminal tube.

One flowering tree which has been introduced into India by the Forest Research Institute deserves mention. This is *Chorisia speciosa* St Hil., a South American species. The trunk is bottle-shaped and covered with conical-shaped prickles and is green in colour. The five petals are 4-5 in. long, strap-shaped or somewhat spathulate, white, pink at the tip, pale-yellow at the base and with dark specks towards the base. A most striking tree, which is in danger of becoming known as the Orchid tree.

31. MALVALES

Herbs or small shrubs; flowers hermaphrodite, actinomorphic; ovary superior, syncarpous; stamens monadelphous; anthers 1-locular; embryo usually straight; endosperm present.

57. MALVACEAE

Herbs or shrubs, sometimes climbers, rarely small trees, often with fibrous tissue in the bark and bast. Indumentum stellate or lepidote. Leaves alternate, often long petioled, palmately nerved, entire or often palmately lobed, stipulate. Flowers actinomorphic, hermaphrodite, rarely dioecious or polygamous, usually solitary, less often in racemes, corymbs or panicles. Calyx of 3-5 sepals, more or less united, usually subtended by an epicalyx; lobes valvate. Petals free from each other but often adnate to the staminal column, contorted or imbricate. Stamens numerous, hypogynous; filaments monadelphous, separate at the apex and bearing reniform 1-locular anthers, which open lengthwise by slits. Pollen muricate or echinulate. Ovary 2- or more-locular, often 5-locular. Ovules one or more at the inner angle of the loculus. Fruit dry, rarely baccate, often capsular, loculicidally dehiscent. Seeds with scanty endosperm and a curved embryo.

The members of this family are nearly always herbs or shrubs but one or two reach the size of small trees. The genus *Hibiscus* Linn. will be known to everyone through the numerous beautiful shrubby species which are so common in gardens throughout India. Two wild species, however, grow into small trees.

H. macrophyllus Roxb. is a small or middle-sized tree, often found on abandoned hill-jhums in Assam and Burma, and in secondary forest. *H. tiliaceus* Linn. is a small tree of the beach and tidal forests. It is quite common along the coasts of India and ascends streams as far as the water is brackish. A large number of other species are found, some of them woody climbers, in the forests, others as more or less conspicuous shrubs. *H. lampas* Cav. (also known as *Thespesia lampas* Dalz. et Gibs.) is a pretty herb, almost a shrub, of grassy areas in the hills; its very large yellow flowers with a maroon eye are most attractive. *H. cannabinus* Linn., the Deccan Hemp, is cultivated for its valuable fibre. *H. sabdariffa* Linn., the Roselle, is cultivated in gardens for its fleshy, red calyx which can be made into an excellent jelly.

Thespesia populnea Cav., the Indian Tulip or Portia tree, is a small tree with entire leaves and lepidote indumentum (which separate it from *Hibiscus*), very common on the seashores of south India, Chittagong and Burma. It is a favourite avenue tree in south India and is often planted inland.

The cotton plant, *Gossypium* spp., belongs to this family and its species are widely cultivated all over India in hills and plains.

Kydia calycina Roxb. is also a small tree with pinkish flowers widely spread in India, where it comes up thickly in secondary growth in hill-jhums. It has assumed importance in recent years from the discovery at the Forest Research Institute that its wood is suitable for mechanical paper-pulp. The bark of the tree is grey, peeling off in irregular flakes, and yields a strong fibre. *K. jujubifolia* Griff. is very similar but has white flowers. It is found in the lower hill-forests of Bengal.

A number of the herbaceous species of *Urena*, *Abutilon* and *Sida* possess valuable fibres in the stem.

32. MALPIGHIALES

Climbers with opposite leaves ; flowers subzygomorphic, hermaphrodite ; ovary superior, syncarpous ; stamens usually ten, 2-locular ; embryo straight, curved or circinate ; endosperm absent.

58. MALPIGHIACEAE 59. LINACEAE

58. MALPIGHIACEAE

Climbing shrubs often with appressed medifixed hairs. Leaves (in the Indian genera) opposite, entire, simple, with glands often present on the blade near the base or on the petiole. Stipules small or absent. Flowers hermaphrodite, actinomorphic or

zygomorphic, arranged in axillary or terminal panicles. Sepals five, connate at the base, imbricate or valvate, one or more with two large glands on the outside or glands absent (*Aspidopterys*). Petals five, clawed or not, fimbriate or dentate. Disk obscure. Stamens ten, hypogynous or perigynous; filaments free or connate at the base; anthers short, 2-locular, opening lengthwise. Ovary 3-locular; ovules solitary in each loculus. Fruit, in the Indian genera, one or more winged samaras.

There are two genera of this family found in the Indian forests—*Hiptage* and *Aspidopterys*. In the former the flowers are zygomorphic, in the latter actinomorphic. The members of this family have hairs which are medifixed, and often exhibit large glands on the calyx and on the petioles, as well as on the leaves. The fruit is a samara, that of *Hiptage* terminating in three long wings, while that of *Aspidopterys* is surrounded by a circular wing. Both these genera are represented as sturdy climbing shrubs.

59. LINACEAE

Herbs or shrubs, sometimes scrambling, or small trees. Leaves usually alternate, simple, entire or rarely serrate-crenate. Stipules lateral, interpetiolar or wanting. Flowers actinomorphic, hermaphrodite, variously arranged. Sepals five, rarely four, imbricate, persistent, connate at the base. Petals five, contorted, fugaceous. Stamens as many as the petals and opposite to them, often with as many staminodes alternating with them, united at the base into a ring; anthers versatile, introrse, opening by slits. Disk usually of five glands adnate to the staminal tube. Ovary free, entire, 3-5-locular, ovules two in each loculus. Fruit a capsule, septicidally dehiscent. Seeds with or without endosperm.

This family, which contains numerous handsome garden-plants, is represented in India by one or two interesting genera. *Hugonia mystax* Linn. is a sarmentose shrub found in southern Madras State. The plant climbs by means of woody circinate spines, which occasionally bear flowers and are therefore modified peduncles. The genus¹ *Erythroxylon* Linn., of which the best-known species is the American *E. coco* Lamk., the source of cocaine, is also found in India and is represented by small trees in south and north-east India as well as in Burma.

The shrub *Reinwardtia trigyna* Planch. is very common in the Dun, and in other parts of India, ascending in the hills to 5,000 ft. It has very handsome yellow flowers and deserves to be grown in gardens more extensively than it is.

¹ Now in a family of its own, *Erythroxylaceae*.

33. EUPHORBIALES

Trees, shrubs or herbs ; flowers monoecious or dioecious, actinomorphic, hypogynous ; ovary superior ; placentation axile ; stamens solitary to very numerous ; embryo straight ; endosperm copious.

60. EUPHORBIACEAE

Trees, shrubs or herbs, sometimes with milky juice. Leaves alternate, sometimes opposite (*Mischodon*, *Trewia*, some *Mallotus*, *Excoecaria*), simple, rarely compound (*Bischofia*), usually stipulate. Inflorescence very various. Flowers usually unisexual, mostly monoecious, sometimes dioecious, actinomorphic or slightly zygomorphic. Calyx and corolla both present or the latter or both absent. Sepals 3-5, valvate or imbricate or absent, gamosepalous. Corolla 3-5-merous, absent or rarely present, sometimes gamopetalous (*Jatropha*). Stamens 1-very many; filaments free or connate, erect or inflexed; anthers 2-(3-4)-locular, opening by slits or by pores. Rudimentary ovary often present in the male flowers. Ovary superior, as a rule with three loculi; carpels more or less united; ovules one or two in each loculus, pendulous; styles free or united at the base; funicle often thickened. Disk, when present, annular, or of separate glands. Fruit a capsule or drupe. Seeds usually with copious endosperm; embryo straight.

This is a very large and difficult family. Students have as a rule no difficulty about the family itself, except in the case of certain species of *Euphorbia*, which, when not in flower, are often thought to belong to the family *Cactaceae*. Pedicelled filaments, 3-lobed ovaries or fruits, cyathia and the like are points to look for when attempting to run down this family. It is a different matter with genera for keys are so long that students are apt to get lost. This, however, cannot be helped as the family is so enormous.

Fruits not echinulate:

Leaves not peltate and at the same time white or rusty-tomentose beneath or if so dark-green above:

Inflorescence of many pedicelled bracteolate stamens as male flowers surrounding a single pedicelled female flower, the whole surrounded by an involucre; stems fleshy ... 1. *Euphorbia*

Inflorescence not as above; stems not fleshy:

Leaves trifoliate:

Juice red ... 2. *Bischofia*

Juice white, rubbery ... 3. *Hevea*

Leaves not trifoliate:

Loculi of the ovary 2-ovuled:

Leaves alternate (4-26) : [for Whorled cf. p. 169]

Petals present, small:

Calyx valvate; filaments in a column:

Fruit a drupe with 2 pyrenes; ovary
2-locular ... 4. *Bridelia*

Fruit a capsule; ovary with
3 loculi ... 5. *Cleistanthus*

Calyx imbricate; filaments free
6. *Actephila*

Petals absent:

Disk present, often conspicuous and of
glands (7-17):

Flowers (male at least) in clusters

(7-16):
Fruit a dry capsule of 3 2-valved
cocci (7-12):

Calyx lobes equal in number in
both sexes, 5 or 6 (7-10):

Calyx-lobes 6 in male and
female:

Stamens 3, the fila-
ments connate

7. *Pseudoglochidion*

Stamens 6, the fila-
ments free

8. *Chorisandra*

Calyx-lobes 5 in male and
female:

Stamens 5

9. *Neopeltandra*

Stamens 3

10. *Phyllanthus*

Calyx-lobes less than 5, or un-
equal in sexes:

Calyx-lobes 4 in male and
female; stamens 4 with
connate filaments

11. *Prosorhus*

Calyx-lobes 4 in male, 6 in
female; stamens 2 or 4; fila-
ments connate

12. *Reidia*

Fruit a berry:

Fruit small, fleshy 13. *Kirganelia*

Fruit large:

Calyx-lobes 5-6 14. *Emblica*

Calyx-lobes 4 15. *Cicca*

Fruit dry or fleshy with 6 cocci;
stamens 5 16. *Flueggea*

Flowers in spikes or racemes, often
panicked; ovary 1-locular

17. *Antidesma*

Disk present, not of glands:

Disk central, orbicular; stamens 4 - many:

Ovary 1-locular; drupe 1-seeded

18. *Hemicyclia*

Ovary 2-4-locular; drupe 2-4-seeded

19. *Cyclostemon*

Disk combined with the calyx-lobes;
stamens 3, in a column:

Anthers sessile on the angles of the
column ...

20. *Sauropus*

Anthers adnate to the column

21. *Melanthesa*

Disk absent:

Stamens connate by their connectives
into a column

22. *Glochidion*

Stamens free, or, if connate, by the fila-
ments only:

Flowers in spikes or racemes:

Fruit capsular:

Seeds without an aril

23. *Aporosa*

Seeds with an aril

24. *Baccaurea*

Fruit a drupe

25. *Daphniphyllum*

Flowers not in spikes or racemes

26. *Putranjiva*

Leaves whorled [for Alternate cf. p. 167]

27. *Mischodon*

Loculi of the ovary 1-ovuled:

Filaments inflexed in the bud; pistillode absent

28. *Croton*

Filaments erect; if inflexed, then pistillode conspicuous:

Calyx in male valvate (30-43):

Petals present in male flowers:

Lepidote or stellate-pilose ...

29. *Aleurites*

Not lepidote or stellate-pilose

30. *Agrostistachys*

Petals absent in male flowers:

Filaments not branched:

Anthers not vermiculiform or linear:

Anther-loculi pendulous or adnate:

Anthers 2-locular:

Stamens numerous:

Fruit indehiscent ...

31. *Trewia*

Fruit dehiscent ...

32. *Mallotus*

Stamens 2-9:

Filaments inflexed

33. *Symphyllia*

- Filaments not inflexed:
 - Filaments dilated 34. *Coelodepas*
 - Filaments slender 35. *Alchornea*
- Anthers 4-locular, or 2-locular and 4-valved:
 - Connective produced; capsule large 36. *Cleidion*
 - Connective not produced; capsule small 37. *Macaranga*
- Anther-loculi discrete, ascending, divaricate:
 - Racemes interrupted ... 38. *Micrococca*
 - Racemes uniformly floriferous 39. *Claoxylon*
- Anthers vermiculiform or linear 40. *Acalypha*
- Filaments branched:
 - Leaves entire, penninerved:
 - Calyx-lobes of female soon deciduous 41. *Homonoia*
 - Calyx-lobes of female accrescent 42. *Lasiococca*
 - Leaves palmati-lobed ... 43. *Ricinus*
- Calyx in male imbricate:
 - Petals present in male flowers:
 - Petals free:
 - Stamens numerous:
 - Flowers paniculate:
 - Leaves palmati-nerved 44. *Jatropha*
 - Leaves penninerved ... 45. *Tritaxis*
 - Flowers not paniculate:
 - Calyx enlarged under the fruit:
 - Female flowers petaliferous 46. *Dimorphocalyx*
 - Female flowers apetaliferous 47. *Blachia*
 - Calyx not so enlarged:
 - Female flowers petaliferous 48. *Ostodes*
 - Female flowers apetaliferous 49. *Codiaeum*
 - Stamens 3-8, usually 3 ... 50. *Trigonostemon*
 - Petals connate ... 51. *Givotia*
 - Petals in male flowers absent:
 - Leaves usually deeply lobed; male calyx large, coloured ... 52. *Manihot*
 - Leaves not lobed; male calyx small, not coloured:
 - Leaves pellucid-punctate ... 53. *Gelonium*
 - Leaves opaque ... 54. *Baliospermum*
 - Calyx in male open or slightly imbricate:
 - Spikes axillary, unisexual ... 55. *Excoecaria*
 - Spikes terminal, simple or panicled, bisexual 56. *Sapium*
 - Leaves peltate, white, or rusty-white below, pale-green above ... 57. *Sumbavia*
 - Fruit covered with spines ... 58. *Chaetocarpus*

1. *Euphorbia* Linn. is a tropical genus which contains many herbaceous species and a number of species which reach the size of shrubs or small trees. These woody species are distinguished by an abundance of latex in their cactus-like stems.

The following is a key to the tree species.

Branches spreading, unarmed:

Branches cylindrical ... *E. tirucalli*
 Branches flat ... *E. epiphylloides*

Branches thick, fleshy, covered with stipular spines:

Main stems practically none ... *E. caducifolia*

Main stems present, thick and tree-like:

Branches with 5 longitudinal ridges *E. royleana*

Branches without 5 longitudinal ridges:

Leaves large oblanceolate, usually at least 6 in. long:

Branches cylindric with pairs of straight spines
 inserted on flat corky bases arranged in vertical
 lines ... *E. nivulia*

Branches more or less angular with small pairs of
 spines on corky bases arranged in spiral lines

E. nerifolia

Leaves small, usually very early deciduous; branches
 angular:

Styles simple:

Branchlets 3-winged *E. trigona*

Branchlets 5-winged *E. cattimandoo*

Styles bifid at the apex:

Branches thick and broad, 3- rarely 5-winged

E. antiquorum

Branches rather slender, 5- rarely 3-winged,
 much twisted ... *E. tortilis*

E. tirucalli Linn. This tree is a native of tropical Africa and was early taken to India where it is now naturalized in many parts of the country. It is sometimes called the Milk Bush by European residents. This plant is often used as a hedge in dry districts and the latex is used in indigenous medicine. Its success as a hedge-plant is due to the fact that animals are discouraged by the vesicant juice which can be very painful. It is easily recognized by its erect branches and smooth terete polished whorled or fascicled branchlets about as thick as a pencil. The latex contains rubber.

E. epiphylloides Kurz is a small tree with horizontal green, flat and spreading, fleshy branches with sinuate margins. It is found in the Andamans, usually along the seashore.

E. caducifolia Haines is a shrub, densely branched close to the ground. The branches bear rather distant tubercles each with a very black areole from the centre of which emerge two

black stipular spines. The species is found on the coast of Bihar and in the low dry hills of Cuddapah, Madras State.

E. royleana Boiss. is a small tree attaining a height of 15 ft., common on the outer hot dry slopes of the western Himalayas, chiefly between 3,000 and 5,000 ft. where it is often gregarious. It strikes rapidly from cuttings.

E. nivulia Ham. is a tree up to 30 ft. tall with a straight trunk and terete jointed spreading often whorled branches. The stipular spines are in pairs inserted on flat brown or black corky areas, not on swellings on the branches. It is widely distributed in India in the hotter and more arid parts.

E. neriifolia Linn. reaches the size of a small tree. In this species the stipular spines are on tubercles in five spiral rows. It is found commonly in village hedges in Assam, Bengal, Punjab and the Deccan. The latex is used in indigenous medicine. The Cacharis of Assam consider this tree to be sacred.

E. trigona Haw. is a small tree with a thick trunk reaching 6-8 ft. in height. This species is indigenous in the Deccan on dry rocky hills but it is sometimes planted at railway stations and in gardens.

E. cattimandoo W. Elliot is an erect shrub or small tree in the same habitats as the last named plant.

E. antiquorum Linn. This species reaches 25 ft. in height with jointed branches and 3-4-5-winged branchlets; wings sinuate with stipular spines. The stem has a succulent core inside a woody ring. Indigenous in Madras State, it is widely cultivated in the rest of India as a reliable hedge.

E. tortilis Rottl. is easily recognized by the slender twisted branchlets. It is indigenous in the Carnatic or dry hills.

E. pulcherrima Willd., the Poinsettia, and *E. bojeri* Hook. are well-known garden-plants.

2. *Bischofia* Bl. *B. javanica* Bl. is a large deciduous, occasionally evergreen, tree with trifoliate leaves. The bark is dark-brown or grey, smooth in young, flaky in old trees, and the outer layer can be readily rubbed off by the fingers; the blaze is soft and pink and a red juice exudes from vessels set in wavy parallel rows. The soft bark is often used by tigers for cleaning their claws. This tree has a wide distribution. It is absent from the driest districts, being characteristic of most shady ravines, river-banks and swamps. In Assam it is found on alluvial sandy soil where the water-table is not very deep. The wood is fairly durable, very durable under water, and has been used for piles, bridges and sleepers. It is crimson in colour with a strong odour of vinegar. The timber is known in the trade as Bishop wood.

3. *Hevea* Aubl. *H. brasiliensis* Muell.-Arg. is the Para Rubber tree of Brazil. It is cultivated in a few places in

Madras State and is grown sometimes for ornament or in botanical gardens. The leaves are trifoliate on long petioles and the tree is, on that account, sometimes confused with *Bischofia* and with *Crataeva*. *Hevea* has a white latex, *Bischofia* a red latex, while *Crataeva* has none. The bark of the tree is smooth and the leaves turn a bright-red or vivid orange-brown as they wither. As is well known the tree supplies the latex which can be converted into a very high grade rubber. Enormous plantations of this species have been created in Malaya and Burma.

4. *Bridelia* Willd. The only species of *Bridelia* which is of interest to forest officers is that described as *B. retusa* Spreng. in the *Flora Brit. India*. Under *B. retusa* there are three varieties quoted by Hooker f. These are vars. *squamosa*, *roxburghiana* and *glauc*a. All of these varieties have been given specific rank by Gehrman.¹

This is his key for the four species.

Flowers in clusters in spikes, monoecious *B. retusa*

Flowers in clusters in leaf-axils, dioecious:

Leaves rotund at the base, alternate, acute towards the apex

B. squamosa

Leaves ovate-elliptic, tomentose, rotund at the apex

B. roxburghiana

Leaves elliptic, narrow at base and apex

B. cinerascens

The distribution of these species is as follows.

B. retusa Spreng. (*sensu stricto*): Widely spread in India

B. squamosa (Muell.-Arg.) Gehr.: West coast of India

B. roxburghiana (Muell.-Arg.) Gehr.: Western India

B. cinerascens Gehr. (*B. retusa*

Spreng. var. *glauc*a Hk. f.): Western India

B. retusa Spreng. is a small or moderate-sized tree with conical spines on the branches and stem when young. The leaves are shed in the hot season and turn yellowish or reddish before falling. The wood is grey to olive-brown and is very durable. It is highly esteemed for house-posts. The bark can be used for tanning and the leaves as cattle fodder. The fruit is edible.

B. squamosa Gehr., *B. roxburghiana* Gehr. and *B. cinerascens* Gehr. vary little in so far as the wood is concerned. Of the three *B. roxburghiana* is by far the largest.

Several other species are found in India. *B. stipularis* Bl. is a common powerful climber or, when lacking a support, a straggling bush.

¹ In *Engl. Bot. Jahrb.* 41. Beibl. 95.

5. *Cleistanthus* Hook. f. There are three common species of this genus.

Leaves green below:

Leaves broadly elliptic; ovary glabrous *C. collinus*

Leaves ovate to lanceolate; ovary pilose *C. patulus*

Leaves coppery below ... *C. myrianthus*

C. collinus Benth. This small tree is found south of the Ganges and in the Deccan Peninsula. It appears to be more at home in dry districts. The bark is nearly black, rough, exfoliating in rectangular plates; blaze red. The wood is durable and is prized for house-posts, fences etc. as it is not attacked by white ants. The roots and fruit are poisonous and are used to stupefy fish. The globose 3-valved capsule explodes with an audible crack in the hot weather and scatters the seeds.

C. patulus Muell.-Arg., a small tree with a smooth bark, exfoliating in plates; blaze pink or crimson, then yellowish. The wood is, according to Roxburgh, the 'colour of dry rose-leaves', hard and close-grained.

C. myrianthus Kurz is a small or moderate-sized tree with a dark-coloured greenish-brown bark and reddish-brown blaze, found in the semi-deciduous forests in the Andamans. It is easily recognized by the pale copper-coloured under-surface of the leaves (Parkinson).

6. *Actephila* Bl. This small genus has two species in India, neither of them of any importance. *A. excelsa* Muell.-Arg. is a small tree, up to 25 ft. high, found in evergreen climax forests from the Western Ghats to Assam, Burma and the Andamans. Burkill mentions¹ that the Abors of the eastern Himalayas make an excellent drink from the leaves of this tree. *A. puberula* Kurz is a shrub, much resembling the former, and equally common with it in the Andamans.

7. *Pseudoglochidion* Gamble is a monotypic genus, its one species, *P. anamalayanum* Gamble, occurring in the Western Ghats and Anaimalai Hills of Madras State.

8. *Chorisandra* Wight. *C. pinnata* Wight is a glabrous shrub, confined to Madras State, and gregarious on laterite soils.

9. *Neopeltandra* Gamble is a small genus containing a couple of slender undershrubs.

10. *Phyllanthus* Linn. This genus together with the last named, *Reidia* Wight, *Prosoros* Dalz., *Kirganelia* Baill. and *Emblica* Gaertn., make up the *Phyllanthus* of Linnaeus. There are a large number of species divided among these genera but

¹ In *Dictionary of the Economic Products of the Malay Peninsula*, published by the Crown Agents for the Colonies, London, 1935.

the only species of any importance are the two mentioned under *Prosor* Dalz. and *Embl* Gaertn.

11. *Prosor* Dalz., *P. indicus* Dalz. (*Phyllanthus indicus* Muell.-Arg.) is a small deciduous straight tree with a whitish bark and branches covered with white lenticels. It is easily recognized by the blue seeds in a smooth green 3-furrowed capsule. The tree has a rather wide distribution, being found from Assam along the Himalayas through Bihar to the Western Ghats. The wood is apparently not used.

12. *Reidia* Wight. A small genus of shrubs or undershrubs of no particular importance.

13. *Kirganelia* Baill. *K. reticulata* Baill. is a small sarmentose shrub, with green or purple flowers, but of little importance.

14. *Embl* Gaertn. *E. officinalis* Gaertn. (*Phyllanthus emblica* Linn.) is a small to middle-sized tree which is common in deciduous forests throughout India, ascending in the hills as high as 4,500 ft. The feathery light-green foliage is very distinctive. Students are very apt to mistake the leaves for compound leaves, but a careful search will reveal buds in the axils of the so-called leaflets which are, moreover, supported by stipules. The bark of young trees is smooth and grey, in older trees it exfoliates in irregular rounded disks and long strips, exposing the yellowish-buff underlayer. There is a distinct chlorophyll layer at the outer margin of the blaze, the latter being red or crimson. This tree can resist annual fires to some extent. The wood is fairly good and is much used by villagers for their houses and agricultural implements. The fruits of this tree resemble the ordinary gooseberry and contain much gallic acid, and are a very important source of vitamin C. They are often eaten as thirst-quenchers and can be made into sweetmeats. The bark also contains tannin.

15. *Cicca* Linn. *C. acida* Merr. (*C. disticha* Linn.) is a small or moderate-sized tree of uncertain origin which is often cultivated in gardens for its fruits. It is known to European residents as the Star Gooseberry. The green leaves are eaten as a spinach, and the acid fruits are eaten cooked and as a preserve.

16. *Flueggea* Willd. *F. virosa* Baill. (*F. microcarpa* Bl.; *F. obovata* Baill.) is a small tree or large shrub, widespread in India and Burma. The bark is reddish-brown, exfoliating in thin strips; blaze pink. The wood, reddish-white, close-grained and durable, is used for making agricultural implements. Considered by some botanists to be a section of *Securinega* Juss.

17. *Antidesma* Linn. A genus with about fifteen species in India and Burma. Some of them possess an edible drupe but the timber is not considered to be of any great value.

A. bunius Spreng. is a small tree which is found in the ever-green forests of India and Burma and is cultivated in Malaysia. The hard bark is smooth and grey with a pink or reddish blaze.

The fruits are dark-red to black in colour and are pleasantly acid to the taste.

A. ghaesembilla Gaertn. is another species usually found in drier localities and is widely distributed. The fruits of this species also can be eaten and the red wood is sometimes used.

A. diandrum Roth is perhaps the best-known for the fact that the leaves turn bright-red before falling at the beginning of the hot weather. The leaves are somewhat acid and make a good spinach.

18. *Hemicyclia* W. et A. This is a genus of evergreen trees with six species, which are confined to the forests of the Western Ghats, and one or two others in the Andamans and Burma; it appears to be absent from the Himalayas and eastern India. The most important species seems to be *H. elata* Bedd. which is a lofty tree attaining 100 ft. in height according to Beddome, but is usually much less, with a smooth grey bark. The wood of the species is said to be close-grained and durable and to resemble boxwood. The species of this genus have been transferred to *Drypetes* Vahl by some botanists.

19. *Drypetes* Vahl. (*Cyclostemon* Bl.) is a genus of evergreen trees with coriaceous leaves. The species are dioecious, the female flower being solitary. When in fruit certain species, for example *Drypetes confertiflorus* Pax et Hoffm., a tree of the Western Ghats, are apt to be mistaken for species of *Diospyros* on account of their globose fruits. In *Drypetes confertiflorus*, however, the sepals are not accrescent and the top of the fruit is decorated with the remains of the two-lobed style and stigma.

D. macrophylla Pax et Hoffm. is a very common tree in certain parts of the Western Ghats, for example, at Topslip, where it is often subgregarious in the underwood. The coriaceous leaves and horizontal branches, with the flowers appearing on the old wood, distinguish the tree.

20. *Sauropus* Bl. is a small genus of shrubby species with distichous leaves and very similar to it is the genus *Breynia* Forst.

21. *Melanthesa* Blume (*Breynia* Forst). A small genus of rather unimportant shrubs with leafy twigs which simulate pinnate leaves. Each leaf, however, has a bud in the axil. The fruits are developed on the upper surface of the twig and the genus can be thereby distinguished from *Fluggea*, *Glochidion* and *Phyllanthus*.

22. *Glochidion* Forst. is a very large genus with many species in India and Burma. The leaves of the species are alternate and very often oblique, bifarious. The fruit is quite distinctive. It consists of three or more 2-valved cocci, globose, or more often orbicular. The lobes of the fruit are often twice as many as the loculi. The seeds are covered with a bright-red aril-like

coat. The yellowish or green fascicled flowers on long pedicels are also very characteristic. None of these species is of any importance in forestry.

23. *Aporosa* Bl. This genus is represented in India and Burma by a dozen species. They are small evergreen trees which are of little importance in forestry. Some are valued as house-posts and are said to be durable in contact with the ground. The wood rings when the trunk is struck with the back of a dao.

24. *Baccaurea* Lour. This genus has two species in India. One, *B. courtallensis* Muell.-Arg., is found in the Western Ghats forests, while the other, *B. sapida* Muell.-Arg., is found in eastern India from Bengal to Burma and in Bihar. These trees can at once be identified in the field from the fact that the flowers are in longish racemes issuing from tubercles on the stem. Beddome describes the flowers of *B. courtallensis* thus: 'They are found in great profusion, the whole trunk appearing as a crimson mass.' The fruits of both these species are edible and are exceedingly luscious. *B. sapida* is sometimes cultivated. The wood is of no particular value.

25. *Daphniphyllum* Bl. This genus is also represented by two species: one, *D. neilgherrense* Rosenth. (*D. glaucescens* Muell.-Arg. non Bl.), is found in the Western Ghats and shola forests above 5,000 ft., the other, *D. himalayense* Muell.-Arg., in the Himalayas and Assam-Burma hills above 4,000 ft. Both the species are evergreen trees with timber of no particular importance. The wood of the roots of *D. himalayense* is a beautiful red colour. These species have the habit of lauraceous trees.

26. *Putranjiva* Wall. *P. roxburghii* Wall. is a handsome evergreen tree with pendulous branches, widely distributed in the moist deciduous and evergreen forests of India, and also frequently planted as an ornamental tree. The wood is light-grey in colour, fairly hard, even-grained. It is fairly durable and suitable for turnery. The seeds are extremely hard and are made into necklaces which are worn by children.

27. *Mischodon* Thw. *M. zeylanicus* Thw. is the only species found in India and it is confined to the southern portion of the Western Ghats. This is a fairly large much-branched tree with rough brown bark. It is rather rare. The young leaves are bright-red.

28. *Croton* Linn. This is a very large genus of trees and shrubs of which many are found in India. The leaves usually have two stalked or sessile glands at the base and often possess a covering of stellate scales or tomentum, at least when young. Some leaves are 3-5-ribbed at the base. The trees are usually monoecious and the flowers are arranged in a terminal raceme with the male above the female. The genus is of economic importance because of one member, *C. tiglium* Linn., a small

tree, which is both natural and cultivated in India and Burma. The seeds of this species are the source of croton oil, one of the most violent purgatives known. Its violent explosive action and its variability has brought it into disrepute and it is hardly used nowadays, at least in the western pharmacopocias. The powdered seeds are thrown into water to stupefy fish. The bark contains a poison which the Abors of the eastern Himalayas use instead of aconite. *C. caudatus* Geisel is a sprawling shrub often found in the Bengal taungyas where it keeps weeds down. *C. sparsiflorus* Morong. is a small herbaceous shrub, a native of America, which has become naturalized in waste places in many parts of India.

The herbaceous garden-plants with variegated leaves, popularly known as crotons, are species of *Codiaeum* Rumph.

29. *Aleurites* Forst. is a small genus confined to eastern Asia and the islands of the Pacific. There are three species, two of which are certainly cultivated in India.

The three species which are cultivated or are wild in India and Burma can be separated by the following key.

- | | | |
|--|-----|---------------------|
| Fruit fleshy | ... | <i>A. moluccana</i> |
| Fruit not fleshy: | | |
| Fruit wrinkled; seed rugose; glands at the top of the petiole cup-shaped | ... | <i>A. montana</i> |
| Fruit smooth; seed smooth; glands at the top of the petiole globular | ... | <i>A. fordii</i> |

A. moluccana Willd. is a big tree, a native of Malaysia, but now cultivated in various parts of India, and has even run wild as in the Wynaad in Madras State. It has various names such as Candle Nut, Belgaum Walnut, Indian Walnut, etc. The stone inside the fruit is extremely hard. The kernels of the seed are edible but only after roasting. The oil which can be expressed from the seeds has been compared with linseed oil in that it is a drying oil. It is, however, inferior to linseed oil but is used to a considerable extent in the Philippines and in Malaysia for making soaps and paints.

A. montana Wils. is a tree of south-eastern Asia which gives a wood-oil similar to that obtained from *A. fordii*. The oil expressed from the seeds is not of any great account because it polymerizes rapidly to a transparent jelly.

A. fordii Hemsl. This tree, which is the source of the important tung oil, is an inhabitant of China but is now cultivated with success in many parts of India and Burma. The oil is of surpassing excellence, but is not the equal of linseed oil for moist climates. When burned it produces an inordinate quantity of soot, which, according to Burkill, is an important ingredient in the manufacture of China ink. The bark contains tannin.

The flowers of the species of *Aleurites* are handsome.

30. *Agrostistachys* Dalz. There are three species of this genus found in our area, two in India and one in Burma.

Leaves entire; raceme long ... *A. meeboldii*

Leaves not entire; racemes short:

Leaves serrate ... *A. indica*

Leaves sinuate ... *A. gaudichaudii*

A. meeboldii Pax et Hoffm. is a small tree found in the Western Ghats forests of Madras State. The leaves are oblanceolate, up to 15 in. long, and erect at the ends of the branches. The racemes are extremely viscid.

A. indica Dalz. is a small tree found in situations similar to the last named; ascending in the hills to 6,000 ft.

A. gaudichaudii Muell.-Arg. is a tree which reaches 60 ft. in height, with large leaves up to 20 in. long. The leaves are used for thatching and for wrapping up opium. It is only found in one area in Tenasserim.

31. *Trewia* Linn. There are two species of this genus in our area.

End branchlets cottony-tomentose; male flowers in long racemes ... *T. nudiflora*

End branchlets glabrous; male flowers in short racemes
T. polycarpa

T. nudiflora Linn. This is a large deciduous tree with leaves remarkably like those of *Gmelina arborea*. This tree is found east and south of the Jumna in India and also in Burma and is characteristic of the swamp forests of the sub-Himalayan tract and is found in moist deciduous as well as in evergreen forest. It reaches fine proportions in the forests of the Western Ghats in Madras State. The bark is yellowish-brown or light-grey in colour and smooth on young trees, flaking on older stems (somewhat like that of *Anogeissus latifolia*); blaze white, soft. The stipular lines are visible on the branches and young stem, although the stipules are minute and caducous. These lines may help to distinguish the tree from the pubescent form of *Gmelina arborea*: the similarity of the leaves of the two species is striking. There is one difference in the leaves of the two which is perhaps worth noting. On the lower surface of the leaf of *Gmelina* between the primary nerves are to be found one to several large glands. On the under-surface of the leaf of *Trewia*, on the other hand, are two glandular areas near the top of the petiole. A further difference is in the bark of the trunk. This in *Gmelina* exfoliates in large irregular plates leaving light-coloured patches behind. The wood of *Trewia* is white and soft and is used for carving and making toys, packing-cases, planking and plywood. It is also said to be used for

making drums, possibly because of the confusion which exists between *Treulia* and *Gmelina*, the latter furnishing excellent wood for drums.

T. polycarpa Benth. Perhaps not a good species. Confined to the Western Ghats, where it reaches a fair size in the evergreen forests.

32. *Mallotus* Lour. is a genus which contains a considerable number of shrubby, rarely tree, species, of which about thirty are found in India and Burma. The chief difference between this genus and *Macaranga* is that the latter has 4-locular anthers and *Mallotus* 2-locular anthers. Several species of *Mallotus* are extremely like species of *Macaranga*. Apart from these the genus is fairly clear cut. Most of them have leaves which are several times as long as broad and ribbed from the base. The under-surface is often covered with glands, sometimes golden in colour (*M. aureo-punctatus*), sometimes red. *M. albus* Muell.-Arg. is a moderate-sized tree with an appearance like a *Macaranga*. The leaves are as long as broad, narrowly peltate, and covered with a fulvous or white stellate tomentum. The fruits are fulvous-tomentose capsules covered with soft woolly spines. The seeds are black.

M. philippensis Muell.-Arg. is another well-known species which has a wide distribution, being found in most parts of India and Burma (absent from Punjab). It is a small tree with an irregular trunk with grey bark; blaze red. The top of the petiole is curved and the blade of the leaf is set at an angle. This is a characteristic trait. If the under-surface of the leaf be examined, it will be found to be covered with small red glands. The fruit is a 3-valved capsule coloured red from the numerous red glands upon it. A dye, called *kamela*, can be collected from the fruits and silk boiled with this dye and alum becomes a beautiful rich golden red. The colour fades after a time if exposed to sunlight but is fast to soaps, acids, etc. This dye is also used in medicine and in Hindu ceremonies.

33. *Symphyllia* Baill. *S. mallotiformis* Muell.-Arg. (*Adenochlaena indica* Hook. f.) is a small tree found in the Western Ghats forests in Madras State. The leaves and the manner in which the blades are set on the petioles is strongly reminiscent of *Mallotus*, a circumstance which has occasioned the specific name.

34. *Coelodepas* Hassk. *C. calycinum* Bedd. is a small tree with very hard wood found only in southern Madras State.

35. *Alchornea* Sw. is a genus with a few tree species in India and Burma. The species are only small trees and are not of any importance.

36. *Cleidion* Bl. *C. spiciflorum* Merr. (*C. javanicum* Bl.) is an evergreen tree of moderate size found in the climax forests of the wetter parts of India. The petioles are rather long and are swollen at both ends; the swellings become characteristically

rugose when dry. The fruit of *Cleidion* is diagnostic. It consists of two adjacent globular seeds with the axis continued beyond them into a mucro.

37. *Macaranga* Thouars. The species of this genus are important because they are often the first to appear on abandoned hill-fields and clearings in the forests and, being of extremely rapid growth, quickly cover the soil and prevent excessive erosion. All *Macarangas* in some indefinable way look alike; perhaps it is their peltate leaves and awkward stems and branches. A number have a conspicuous glaucous bloom on the younger parts. The bark is often rough from numbers of raised lenticels, and that of the younger parts shows particularly large scars where the leaves have fallen away. Mention has been made above to the similarity of this genus with *Mallotus*.

Dr Cowan published a key to the common species of *Macaranga* and *Mallotus* of Bengal.¹ It is reproduced below.

Leaves peltate; petiole inserted at least 0.25 in. from the base of the leaf:

Stellate hairs present; mature leaves villous or tomentose beneath:

Under-surface white or rusty-white with a dense tomentum ... *Mallotus albus*

Under-surface green or yellowish-green, hairy, especially on the veins and veinlets

Mallotus roxburghianus

Stellate hairs absent; mature leaves glabrous:

Basal ribs 10-12, marginal glands near the apex; bracts leaf-like ... *Macaranga denticulata*

Basal ribs 9, the outer descending pair with 2 elongate glands; marginal glands some distance below apex; bracts with a glandular tip *Macaranga indica*

Leaves not peltate; petiole not inserted more than 0.25 in. from the base of the leaf:

Leaves about as broad as long:

Small trees:

Leaves glabrous ... *Macaranga pustulata*

Leaves white-tomentose below *Mallotus albus*

Climbing shrub ... *Mallotus repandus*

Leaves much longer than broad:

Under-surface dotted with red glands

Mallotus philippensis

Under-surface without red glands:

Under-surface with a yellowish-green tomentum; leaves ovate, 4-10 in. long *Mallotus nepalensis*

Under-surface glabrous; leaves lanceolate, 3-4.5 in. long ... *Macaranga gamblei*

¹ In *The Ind. For.*, 55, 230, 1929.

M. denticulata Muell.-Arg. is a quick-growing tree, very common in secondary vegetation in the hills and also in the plains. In the plains of Bengal it often springs up gregariously in grass-land usually close to the forest margin, and in favourable conditions grows so thickly that the grass is completely killed. Troup has outlined the succession in fire-protected savannah in Bengal. *Macaranga denticulata* establishes itself and kills out the tall grasses. Shade-bearing trees then come in and push up through the *Macaranga* canopy which itself eventually dies or is killed outright. It was at one time considered to be of value because sal seedlings were able to persist under its shade. This has, however, proved to be a delusion as the sal seedling is not able to compete with the *Macaranga* and remains, if it lives at all, in a very depauperate condition.

Other species of *Macaranga* are more or less similar in their capability of reforesting abandoned hill-fields or other cleared areas. What *M. denticulata* is capable of doing in Bengal, *M. roxburghii* does in Madras State and *M. tanaria* in the Andamans.

38. *Micrococca* Benth. Undershrubs or herbs of no particular interest.

39. *Claoxylon* A. Juss. is a small genus of trees or shrubs of which a few species are found in India. *C. polot* Merr. (*C. indicum* Hassk.) is a small tree found in Tenasserim, the leaves of which are purgative in action. The trunk is pale-grey in colour and the bark of younger parts is covered with large leaf scars just as in *Macaranga*.

40. *Acalypha* Linn. A genus of little importance.

41. *Homonoia* Lour. There are two species of this interesting genus in India.

Leaves linear or linear-oblong	...	<i>H. riparia</i>
Leaves obovate or oblanceolate	...	<i>H. retusa</i>

H. riparia Lour. is a shrub or small tree found in river-beds. When it is a tree the trunk is almost entirely concealed in shingle and it sends up its rubbery branches through the shingle to the light. During the rainy season the branches and leaves are submerged, certainly for months, but from the size of the trunk in the shingle it is clear that the trees reach a great age. The appearance of the aerial branches and branchlets recalls to a certain extent those of the willow. The leaves are aromatic and are covered below with conspicuous circular scales.

H. retusa Muell.-Arg. is a small shrub found in rocky river-beds from Madhya Pradesh southwards. It is quite different in appearance and structure from the former.

42. *Lasiococca* Hook. f. *L. symphylliaefolia* Hook. f. is a middle-sized evergreen tree with an irregular bole, only found

in the Tista Valley in Bengal. The bark is thin, white and peels off in small flakes. Nothing is known of its wood.

43. *Ricinus* Linn. *R. communis* Linn., the Castor-oil plant, is so common in India that it will be known to everyone. It is not, however, universally known that it was introduced into India at a remote date from Africa. Apart from the use of the oil as a medicine it can be used for burning; it burns with a clear flame. It is excellent for softening leather. The seeds are poisonous if eaten. The *eri* silkworm is reared upon the leaves in Assam.

44. *Jatropha* Linn. The species of *Jatropha* are of interest to the forester only because of their economic value. The kernels contain an oil which is a purgative, while other parts contain a tanning material. None of the species now widespread in India and Burma seem to be indigenous, but appear to have been introduced from America. *J. curcas* Linn., the Physic Nut, is a shrub or small tree found in almost every corner of India and Burma, where it is often grown as a hedge-plant. Goats do not like it. *J. gossypifolia* Linn. is a native of Brazil but is now common in waste places in India. The leaves are often copper-coloured and are covered on the margins with stipitate yellow viscid glands. *J. multifida* Linn. and *J. podagrica* Hook., the latter with a grotesquely swollen base, are common garden-plants.

45. *Tritaxis* Baill. *T. beddomei* Benth. is the only representative of this genus in India. It is a small tree found in the Western Ghats of Travancore and Tinnevely.

46. *Dimorphocalyx* Thw. This small genus of trees obtains its name from the fact that in the female flowers the calyx-lobes are much larger than those of the male. The species are small, uninteresting evergreen trees with branchlets which are nearly white.

47. *Blachia* Baill. The species of this genus are small evergreen trees or shrubs and are confined to the evergreen climax forests of the Western Ghats, Ceylon and the Andamans.

48. *Ostodes* Bl. The two species of this genus are unmistakable in the forest from their long-petioled long leaves. They are middle-sized to large evergreen trees. *O. zeylanicus* Muell.-Arg. is found in the forests of the Western Ghats. *O. paniculata* Bl. is found in the eastern Himalayas. It gives a gum which is used as a size in the manufacture of paper.

49. *Codiaeum* Rumph. *C. variegatum* Linn. is the garden species with extraordinary leaf-shapes and brilliantly variegated foliage. Horticulturists persist in calling this genus 'croton'.

50. *Trigonostemon* Bl. There are a few species of this genus in India and Burma. They are unimportant evergreen shrubs or trees.

51. *Givotia* Griff. *G. rottleriformis* Griff. is a middle-sized tree

with large cordate leaves covered on the lower surface with a dense white felt of stellate hairs. The bark is smooth and brown, peeling off in circular scales. The wood is white and soft and is suitable for carving. This striking-looking tree is found in the very dry forests of central and southern India.

52. *Manihot* Adans. This genus is found in tropical America, chiefly in Brazil, but several species are cultivated in India.

The two commonest species can be separated by the following key.

Leaves peltate, mostly 3-partite ; small tree	<i>M. glaziovii</i>
Leaves not peltate, mostly 7-partite; shrub	<i>M. utilisima</i>

M. glaziovii Muell.-Arg., the Ceara Rubber tree of Central America. It is a small tree up to 30 ft. tall and is cultivated in gardens in Bengal, Bihar, Madras State and possibly elsewhere. The bark peels off in horizontal strips like that of the cherry tree. The rubber obtained from this tree is of good appearance but contains too much resin. It cannot, therefore, compete with *Hevea brasiliensis*.

M. utilisima Pohl is the Cassava or Tapioca plant. A native of Central America, the shrub is now cultivated in most of the states of India for its tubers which are edible and from which the form of starch known as tapioca can be obtained. Although the tubers are edible and nourishing they contain the deadly hydrocyanic acid, free and combined with a glucoside. The harmful cyanogenetic glucoside can be removed by boiling. The Konyak Nagas cultivate this plant extensively.

53. *Gelonium* Roxb. This genus has four species which are found in the damper forests of India and Burma. The species are small resinous evergreen trees with marked stipular lines on the branchlets. The leaves are occasionally pellucid-punctate. The flowers are often very numerous, sweet-scented. Some of the species are cultivated for this reason.

Leaves widest at or below the middle:

Flowers about 0.3 in. across; fruit rough, globose

G. multiflorum

Flowers about half as wide; fruit 3-lobed *G. lanceolatum*

Leaves widest above the middle:

Fruits about 0.5 in. wide

... *G. glomerulatum*

Fruits 0.25 in. wide

... *G. bifarium*

Distribution of the species is as follows:

G. multiflorum Juss.:

Gangetic plain, south to
Madras State and east to
Bengal and Burma.

G. lanceolatum Willd.:

Malabar Coast

G. glomerulatum (Bl.) Hassk.:

Burma

G. bifarium Roxb.:

Andamans

54. *Baliospermum* Bl. is a genus of small shrubs, some of which are gregarious in evergreen hill-forests of Assam. *B. montanum* Muell.-Arg. (*B. axillare* Bl.) is a small shrub which is gregarious in shady places in the north of India. The leaves and seeds are purgative.

55. *Excoecaria* Linn. This genus contains some half dozen species, one of which is a littoral plant, while the others are found in the evergreen forests of India.

The following three species are fairly common.

Leaves alternate, entire or sinuate-crenate *E. agallocha*

Leaves opposite, serrate or crenulate:

Leaves up to 6 in. long, 1.5 in. broad; male spikes 2 in. long ... *E. crenulata*

Leaves up to 10 in. long, 3 in. wide; male spikes up to 6 in. long ... *E. robusta*

E. agallocha Linn. is a small tree found on the coasts of India, Burma and the Andamans. It is sometimes called the Blinding tree on account of the extremely acrid juice contained in the cortex, which is said by wood-cutters to cause blindness if it enters the eyes. The tree is very common on the seashore where it grows into a bushy tree, often with an inclined trunk and many vertical branches. This species is leafless for a couple of months in the hot season. The leaves turn bright-yellow or red before falling. The bark is grey with the red-brown lenticels forming irregular vertical or diagonal stripes. The wood is largely used as firewood, having a fairly high calorific value.

E. crenulata Wight and *E. robusta* Hook. f. are small evergreen trees exuding a copious white latex when blazed. They are often found in the evergreen forests of the Western Ghats.

E. cochinchinensis Lour. (*E. bicolor* Hassk.) is a pretty shrub, a native of Indo-China, which has been introduced into gardens on account of its leaves, which are green above and red below. According to Burkill the latex of the plant is more corrosive and poisonous than that of *E. agallocha* and kills fish more readily.

56. *Sapium* P. Br. This genus has about five species in India and Burma.

The following is a key to the species.

Petioles biglandular:

Leaves broadly ovate or ovate-rhomboid *S. sebiferum*

Leaves not as above:

Leaves elliptic or oblong-elliptic, serrate, 4-6 in. long

S. insigne

Leaves ovate, acute at base, 2-4 in. long

S. eugenifolium

Petioles eglandular:

Leaves narrowly elliptic with two glands at the base of the blade, 1.5-4.5 in. long	...	<i>S. indicum</i>
Leaves ovate, 3-8 in. long	...	<i>S. baccatum</i>

S. sebiferum Roxb. This small tree, a native of south-east China, was introduced into India many years ago, and has now become naturalized in many places in northern India. It is a small or medium-sized deciduous tree with a crooked stem and rough, slightly fissured, bark. The leaves assume their autumn tints of pale-lemon to crimson in the cold weather and in the mass constitute a striking blaze of colour. The tree is known to European residents by the name Chinese Tallow tree. The seeds are covered with a layer of white oily cells and this oily substance can be made into candles. The leaf is not unlike that of *Dalbergia sissoo* and the tree, too, at a distance is not unlike the *sissoo* tree. The timber is not used.

S. insigne Trim. is a small tree with thick pale-brown succulent branches and rather fleshy large leaves crowded at their ends; bark smooth, grey and shining when young, rough and corky when old; blaze pale with much milky juice. This tree is found all over India and is sometimes planted as a hedge; cuttings of the young branches root readily.

S. eugenifolium Buch.-Ham. is a handsome tree found in the lower foot-hills of the eastern Himalayas and in the Khasi Hills. The leaves turn bright-red before falling.

S. indicum Willd. This species has a very wide distribution in India in the wetter parts, especially on the sea-coasts. A greenish-yellow dye may be obtained from the leaves.

S. baccatum Roxb. This handsome tree is found in eastern India and Burma, often in evergreen climax forest. Parkinson says it occurs in the evergreen forests of the Andamans associated with *Endospermum chinense* and *Sideroxylon longipetiolatum*. The young leaves, which appear in April, are orange-red in colour. The withered leaf is yellow with a bright-red petiole. The fruits when ripe are purple-black and sweet, attracting large numbers of Imperial Pigeon.

57. *Sumbavia* Baill. *S. macrophylla* Muell.-Arg. is a small tree with peltate leaves, pale-green above, covered below with a dense-white, or sometimes a rusty-white, tomentum. This species is apt to be taken at first sight for a *Mallotus* or *Croton*. The tree is found in the evergreen forests of Assam, Manipur and doubtless in Burma.

58. *Chaetocarpus* Thw. *C. castanicarpus* Thw. is a middle-sized evergreen tree with a greyish warty bark, found in the evergreen forests of Assam, Chittagong and Burma. The echinulate capsules are quite distinctive.

34. THEALES

Trees, shrubs or climbers ; flowers hermaphrodite, actinomorphic ; ovary superior with axile placentation ; stamens numerous ; embryo straight or curved ; endosperm scanty or absent.

61. THEACEAE 62. OCHNACEAE

63. ANCISTROCLADACEAE 64. DIPTEROCARPACEAE

61. THEACEAE (TERNSTROEMIACEAE)

Trees or shrubs. Leaves alternate, simple, coriaceous or membranous, evergreen, often fascicled at the top of the branches, exstipulate. Inflorescence of racemes or panicles but usually of solitary axillary flowers. Flowers usually showy, actinomorphic, hermaphrodite, rarely unisexual. Sepals five, free or slightly connate at the base, much imbricate. Petals five, hypogynous, free or connate, imbricate or contorted. Stamens many (in Indian species), often very many, hypogynous, free or connate at the base, sometimes adnate to the base of the petals; anthers 2-locular, basifixed, erect, or dorsifixed and versatile, opening by a longitudinal slit (in Indian species). Ovary superior, 3-5-locular; styles free or connate, as many as the loculi; stigmas pointed or obtuse; ovules 2 - many in each loculus on axile placentas, erect, horizontal or pendulous, anatropous. Fruit fleshy and indehiscent, or a capsule, generally dehiscing loculicidally. Embryo large, straight or curved; endosperm little or none.

This family is not of much importance from the forest officer's point of view in that the very great majority of the species contained in it are evergreen or deciduous small trees or shrubs, many of them occurring in the undergrowth of hill-forests. The tea plant, *Camellia sinensis* O. Ktze. is an evergreen shrub or small tree said to be indigenous in the evergreen hill-forests of Assam and Burma. This, however, has never been proved and any specimens so far seen cannot be said to be truly wild. The hill-tribes cultivate this plant in clearings in the forest where it grows into a tree 20-30 ft. tall, very unlike the low trim bush of the tea-garden. The cultivation of the tea-bush, as is well known, reaches enormous proportions in India and Ceylon.

There is one tree in the family which is well known in eastern India. This is *Schima wallichii* Chois. It is very common in sal and mixed deciduous forest in the plains and hills, and is to be found even at altitudes of 7,000 ft. This tree reaches an enormous size in sal forest and is characterized by its showy white fragrant flowers and very thick soft bark. If the bark be blazed and the cut surface examined with a hand-lens, it will be found that there are numerous needle-shaped crystals of oxalate present. These crystals are responsible for the intense itching which is experienced if the bark is allowed to come into contact with the skin. The Nepali name of the tree is *chilauni*, which means

itching. On account of its thick bark this tree can stand fire to a considerable extent. Its presence is said to indicate that the soil is particularly suited to sal. The timber is reputed to be good but it warps and splits very badly. A closely allied species, *S. khasiana* Dyer, is found in the Khasi Hills; it has larger flowers and capsules.

Students are apt to leap to conclusions and assume from a superficial examination of the flowers of *Schima* and *Camellia* that these genera belong to the *Rosaceae*. Most people without a knowledge of systematic botany will say that the flower of the tea plant is like a tea-rose. This mistake can easily be avoided by remembering that in *Theaceae* the calyx consists of imbricate sepals slightly connate at the base, while in *Rosaceae* there is a definite calyx-tube. Moreover the gynaecium consists of one or more carpels which are free or connate in various ways, not as in *Theaceae* where the ovary is 3-5-locular.

Gordonia dipterosperma Kurz is a very large tree of eastern India, where it flourishes in the hills between 4,000 and 6,000 ft. The flowers differ from those of *Schima* by the fact that the stamens are gathered into several bundles and by the shape of the capsule, which is oblong. The flowers are large and white. Another species of this genus, *G. obtusa* Wall., is found in the Nilgiris, where it flourishes in the drier sholas.

62. OCHNACEAE

Shrubs or trees with watery juice. Leaves alternate, simple, glabrous, stipulate; stipules sometimes laciniate, sometimes almost interpetiolar. Flowers hermaphrodite, actinomorphic, yellow or orange, on jointed pedicels, arranged in racemes or panicles. Sepals five, free, imbricate. Petals five or more, imbricate or contorted. Stamens 10 - many; anthers long, linear opening by slits, basifixed. Ovary deeply 3-10-lobed and 3-10-locular. Ovules one in each loculus. Fruit of 3-10 drupes sessile upon the enlarged torus or disk. Seeds with or without endosperm.

Two genera of this family are found in India, *Ochna* Schr. with numerous stamens, and *Gomphia* Schr., with ten.

There are several species of *Ochna* which, because of their pretty flowers, are likely to excite attention.

Key (after Gamble)

Flowers large:

Flowers in axillary or lateral racemes:

Leaves closely nerved, serrate or shortly crenate:

Leaves membranous; stigmas minute *O. squarrosa*

Leaves coriaceous; stigma lobed ... *O. gamblei*

Leaves coarsely and irregularly nerved, broadly crenate
O. beddomei

Flowers in subterminal umbels; dwarf shrubs *O. pumila*
Flowers small:

Leaves elliptic or ovate; nerves close ... *O. wightiana*

Leaves oblong-lanceolate; nerves inconspicuous

O. heyneana

The flowers of all these species are yellow. *O. squarrosa* Roxb. is often planted for ornament but it is wild in Assam, Burma, in central and south India. The bark is smooth, grey, with a pink blaze which is red just against the wood. The other species are mostly south Indian.

Gomphia angustifolia Vahl is a small tree found in the ever-green forests of the Western Ghats.

63. ANCISTROCLADACEAE

Climbing shrubs with strong hooked tendrils terminating the principal branches. Leaves entire, sessile, lanceolate, stipulate; stipules minute, caducous. Flowers bisexual, actinomorphic, arranged in small terminal or axillary panicles; calyx adnate to the ovary, 5-lobed; lobes imbricate, becoming enlarged and wing-like in the fruits. Petals five, shortly connate at the base, contorted. Stamens five or ten, filaments broad, short, connate at the base. Anthers 2-locular, opening lengthwise. Ovary 1-locular; ovules solitary. Fruit a nut surrounded by the wing-like enlarged calyx-lobes.

The genus *Ancistrocladus* Wall. contains a number of glabrous climbers, often of large size, which are very readily recognized in the forest from the winged dipterocarp-like fruit and the recurved tips of the branches which act as climbing hooks. *A. heyneanus* Wall., a common climber of the Western Ghats, starts life as an erect shrub with very long (18 in.) narrow leaves. When it reaches a branch, perhaps 12-15 ft. above the ground, it climbs rapidly but the leaves at once relapse to their normal size of 4-9 in.

64. DIPTEROCARPACEAE

Trees, often of gigantic size, or shrubs, with resinous juice, mostly evergreen. Leaves alternate, coriaceous, simple, stipulate; stipules small or large, caducous or persistent, sometimes sheathing and leaving an annular scar on the shoot. Indumentum of stellate hairs or peltate scales on the younger parts. Inflorescence of axillary or terminal spikes, racemes or, most often, of panicles. Flowers regular, hermaphrodite, fragrant. Calyx in flower free and campanulate, rarely short or adnate to the torus or base of the ovary; torus broad, fleshy, flat or obconical, often concave. Calyx 5-lobed; lobes imbricate when young, often enlarged in the fruit into foliaceous wings. Petals five, free or connate at the base, strongly contorted. Stamens five, ten, fifteen or very many; anthers 2-locular, dehiscing introrsely

by slits; the connective often produced into an awn; filaments short, often dilated at the base, free or connate. Ovary 3-locular, often prolonged into a fleshy stylopodium, in some cases immersed in the receptacle; ovules two in each locus, pendulous or lateral, anatropous, on an axile placenta. Fruit indehiscent, rarely dehiscent (*Vateria*), often winged, usually 1-seeded. Seeds without endosperm; cotyledons fleshy, often twisted, enclosing the radicle, 2-lobed; lobes stalked.

This family is of very great importance for it contains not only some of the largest trees of our forests, some of which yield very valuable timber, but also some which yield valuable oils and resins. *Gurjan* oil, *Eng* oil, Indian *Copal* (White Dammar) are produced by species of this family.

Resin-canals are to be found in the wood of all the species of the family, and they also occur sometimes in the leaves. Those in the wood are usually arranged in concentric lines. Tyloses are always present and are found clogging the pores and vessels. Essentially these tyloses are balloon-like enlargements of cell-walls projecting into the adjacent cell-lumina. They are formed by the enlargement of the pit membrane of the half-bordered pits between the wood parenchyma- or wood ray-cells and the vessels or tracheids. After they are fully grown they are often filled with gum, resin, starches, etc. Tyloses have a considerable bearing upon the resistance of the wood to fungal filaments. If the tyloses are very numerous they act as an effective barrier to the entry of wood-destroying fungi.

Species in which the wood is full of tyloses cannot be pressure-treated with antiseptics and wood preservatives. Sal is one such timber, but a number of dipterocarps can be impregnated.

The following key will be of use in separating Indian genera.

Stamens more than 20 :

Fruit with 2 long terminal wings :

Stipules large, sheathing; calyx free; style filiform;
stamens very numerous ... 1. *Dipterocarpus*

Stipules small; calyx adnate; style short; stamens 20-35
2. *Anisoptera*
(*Scaphula*)

Fruit without long terminal wings ... 3. *Vateria*

Stamens 10-15, rarely more :

Stamens awned or pointed :

Wings 2 ... 4. *Hopea*

Wings 3 :

Anthers without appendages ... 5. *Shorea*

Anthers with 5 appendages ... 6. *Pentacme*

Wings 5 ... 7. *Parashorea*

Stamens not awned or pointed; appendix of connective
short, obtuse ... 8. *Vatica*

1. *Dipterocarpus* Gaertn. f. This genus is easily recognized in the forest, for, apart from the gigantic size of the trees with regular light-coloured boles and a compact crown of foliage at the top, the fruits, leaves and shoots are very distinctive. The fruit is exactly like a shuttlecock. The turbinate calyx-tube, which has become enlarged in the fruit, bears at the top a number of papery oblong wings. These wings are set at an angle so that when the fruit drops it revolves in the air, whereby its pace is slowed down, so that it can be blown to considerable distances from the tree. As these giants of the forest tower far above the closed canopy formed by their evergreen associates the method of dispersal is as effective as any other. The leaves are elliptic, dark-green, glossy, with regular parallel secondary nerves. The stipules are most characteristic, sheathing the apical bud, and are often very long. The fall of the stipules leaves behind a very conspicuous circular stipular scar. When pressed with the fingers the unopened stipules explode with a definite 'pop'; the halves then bend backwards. After the appearance of the new leaves the fallen stipules are found on the ground in great numbers. The scar of a fallen leaf shows three definite leaf-traces. There are resin-canals filled with a resinous material in most parts of the plant.

Field characteristics of the genus which are diagnostic are the scaly, lenticellate boles, or deeply fissured bark in dry areas, the oil exuding from the cut sap-wood, the large stipules which leave amplexicaul scars on the twigs, and the leathery leaves.

In the keys a distinction must be made between the terminal long papery wings and the ridges or expansions on the surface of the calyx-tube. When the latter are referred to, the calyx-tube is always mentioned.

Species of south India

Tube of fruiting calyx 5-winged; leaf-nerves beneath and young shoots clothed with a spreading tomentum

D. bourdilloni

Tube of fruiting calyx 5-winged; leaves subglabrous; young shoots with a short appressed tomentum

D. indicus

Both these species are magnificent trees reaching 120 ft. or more in height. *D. bourdilloni* Brandis is very restricted in its distribution. *D. indicus* is found in the Western Ghats forests of Bombay State and Madras State.

Species found in the Andamans (after Parkinson)

Leaves perfectly glabrous:

Fruiting calyx-tube with 5 lateral wings or ribs

D. grandiflorus

Fruiting calyx-tube smooth and globular:

Leaves 5-10 in. long; under-surface of leaf rough

D. gracilis

Leaves 3-6 in. long; under-surface of leaf smooth

D. kerrii

Leaves stellate-pubescent on the under-surface; calyx-tube with 5 lateral ribs or wings:

Leaves 5-9 in. long; fruit 1 in. long, with terminal wings

6 in. long

...

D. alatus

Leaves 2-5 in. long; fruit 0.5 in. long, with terminal wings

3 in. long.

...

D. costatus

D. grandiflorus Bl.¹ is an enormous tree, common everywhere in the Andamans and is also found in Burma. It is leafless for a portion of the year.

D. gracilis Bl.² (*D. turbinatus* in Parkinson, *D. pilosus* of Parker). Common in evergreen forests. The under-surface of the leaf is very rough. The bole is grey with reddish patches.

D. kerrii King. A rather uncommon tree of the south Andamans, as stated by Parkinson, but extends into Burma. Its timber is said to be harder than other *Gurjans* and to yield more oil.

D. alatus Roxb. (*D. incanus* Roxb. in Parkinson's *Flora*). The finest tree in the Andamans, reaching 140 ft. in height.

D. costatus Gaertn. f. An uncommon tree with tomentose leaves. The bark is greenish-grey with striking yellow-brown patches.

Species found in Assam, Bengal and Burma

Fruiting calyx winged:

Fruiting calyx-tube winged or ridged at the top only, i.e. tubercled

...

D. tuberculatus

Fruiting calyx-tube winged or ridged from top to bottom:

Calyx-tube winged:

Fruit 0.7-1 in. long (excluding terminal wings); wings

5 in. long

...

D. alatus

Fruit 2.5 in. long (excluding terminal wings); wings

6-9 in. long

...

D. grandiflorus

Calyx-tube ridged:

Fruit globular, 0.5 in. long; wings 3.5-4.5 in long

D. costatus

Fruit ovoid, 1.3-2 in. long; wings 6-9 in. long

D. dyeri

¹ *D. griffithii* Miq. in C. Parkinson, *A Forest Flora of the Andaman Islands*, Government Central Press, Simla, 1923.

² See C. R. Symington, *Notes on Malayan Dipterocarpaceae*, Pt. IV, Government Printing Office, Singapore, 1938.

Fruiting calyx without ridges or wings:

Fruiting calyx with 5 tubercles at the top *D. tuberculatus*

Fruiting calyx without tubercles:

Young twigs, buds, petioles glabrous, slender *D. kerrii*

Young twigs etc. more or less hairy:

Young twigs shaggy, with long golden hairs:

Leaves elliptic or lanceolate-elliptic; bark smooth or scaly; fruit globose, sparsely covered with golden hairs ... *D. baudi*

Leaves broadly ovate; bark deeply fissured; fruit glabrous or covered sparsely with stellate hairs

D. obtusifolius

Young twigs covered with a pale felty pubescence:

Fruit less than 1 in. in diameter ... *D. gracilis*

Fruit more than 1 in. in diameter:

Leaves ciliate on the margins when young; wings of fruit 4-9 in. long, 5-nerved in the lower third

D. macrocarpus

Leaves not ciliate on the margins when young; wings of fruit 4.5-7 in. long, 3-nerved in the lower third ... *D. turbinatus*

D. tuberculatus Roxb. This tree reaches 120 ft. in height and is easily distinguished from all others by the tubercles on the calyx just under the wings. It seems to be confined to Burma. The bark is very thick and fissured in this species, which is found in the drier forests. The tree is locally known as *In*.

D. dyeri Pierre. This species, which also reaches large dimensions, occurs in Mergui in Burma. It is common in Indo-China and Malaya. The bole is light-coloured and the outer bark falls off in small scales.

D. baudi Korthals. This again is a tree common to Burma and Malaya. The hairy fruiting calyx-tube and tomentose leaves of the species are characteristic.

D. macrocarpus Vesque. A tree, common in the Lakhimpur district of Assam, which reaches enormous proportions. It also occurs in Burma. The timber is very largely used for the manufacture of tea-boxes.

D. turbinatus Gaertn. This tree is found in the Surma Valley, Assam, and extends southwards through Chittagong into Burma. It is as large a tree as any of its congeners.

D. obtusifolius Teysm. Not found in India, common in Burma, Siam and Indo-China. It is one of the species with a deeply fissured bark, found in dry forests.

2. *Anisoptera* Korth. This genus in so far as India is concerned is confined to the southern parts of Bengal. The Bengal species is *Anisoptera scaphula* (Roxb.) Pierre, while

it and *A. oblonga* Dyer occur in Burma. The stamens of the latter are long awned while those of the former are apiculate. The inner portion of the blaze is thick, yellow and laminated and is a good diagnostic character of the genus.

3. *Vateria* Linn. There is only one species of this genus in India, *V. indica* Linn., which is found in the forests of the Western Ghats. The young leaves are bright-red in colour. The fruit is a large 3-valved capsule, supported by the remains of the calyx, fleshy, up to 2.5 in. long. The seeds yield a large amount of tallow. This tree is indigenous in the forests of the northern parts of Madras State, but while it is extensively planted by the road-sides in Kanara, it is said not to be wild in Bombay State.

4. *Hopea* Roxb. This genus is for the most part confined to southern India. There is one species, *Hopea shingkeng* Bor, in Assam, there are two in Burma and six in the States of Madras and Bombay. The inflorescence is very distinctive in that the flowers are secund on the branches of the panicle and this arrangement once seen is not likely to be forgotten. Some of the species yield useful timber, e.g. *Hopea wightiana* Wall., *H. odorata* Roxb., *H. parviflora* Bedd.

Gamble gives the following key to the Madras species.

Panicles tomentose	...	<i>H. parviflora</i>
Panicles glabrous:		
Bark black, peeling in strips from below upwards		<i>H. racophloea</i>
Bark brown	...	<i>H. wightiana</i>

The two Burmese species, *H. odorata* Roxb. and *H. helferi*, can easily be separated by the following field characters.

Blaze pink or salmon-red, bark scaly	...	<i>H. odorata</i>
Blaze dull-brown or greenish-yellow	...	<i>H. helferi</i>

The wood of some of the species is valuable for building-timber and house-posts.

5. *Shorea* Roxb. One of the best-known genera in India, some of the species having a very high reputation for the excellence and durability of their timber. The most famous of all the species, of which there are about nine in India and Burma, is undoubtedly *Shorea robusta* Gaertn. f. This is a semi-deciduous gregarious tree covering large areas in Uttar Pradesh, Bengal, Bihar and Assam. Sal timber is of great durability and many lakhs of cubic feet are supplied as sleepers to the railways every year. The most characteristic feature of this tree is its adaptability to wide ranges in the factors of the habitat. Such adaptability is, generally speaking, usually shared by species which are not in themselves climax species. The climate in the area over which the sal tree occurs shows extraordinary

variation. The rainfall varies from 35 to nearly 200 in. in the year, the summer temperature from hot to very hot and the winter temperature from far below freezing to warm. It is believed that its western range is limited by the arid climate of the Punjab. In Assam, however, plantations have been raised outside what was considered its natural eastern limit.

Key to the species of *Shorea* in India, Burma and Ceylon

- Stipules large, persistent ... *S. stipularis*
- Stipules caducous:
 - Appendage to the connective ciliate or barbate:
 - Lateral nerves 8-10 pairs ... *S. tumbuggaia*
 - Lateral nerves 11-16 pairs:
 - Leaves 4-8 in. long:
 - Petioles puberulous ... *S. oblongifolia*
 - Petioles glabrous ... *S. robusta*
 - Leaves less than 4 in. long:
 - Tertiary nerves subparallel ... *S. dyeri*
 - Tertiary nerves reticulate ... *S. reticulata*
 - Appendage to the connective glabrous or slightly hairy at the tip:
 - Leaves ovate-lanceolate ... *S. gratissima*
 - Leaves ovate, elliptic or oblong:
 - Mature leaves hairy on the veins below *S. assamica*
 - Mature leaves not hairy on the veins below *S. talura*

Distribution

- S. stipularis* Thw.: Ceylon
- S. tumbuggaia* Roxb.: Madras State
- S. oblongifolia* Thw.: Ceylon and Burma
- S. robusta* Gaertn. f.: India
- S. dyeri* Thw.: Ceylon
- S. reticulata* Thw.: Ceylon
- S. gratissima* Dyer: Burma
- S. assamica* Dyer: Assam
- S. talura* Roxb.: Madras State

The woods of all the species of *Shorea* listed above are very similar to one another in hardness and durability. For this reason they are highly valued for constructional work, indoor as well as out of doors. Among the better known species, in addition to *Shorea robusta* Gaertn. f., the following may be mentioned. *S. assamica* Dyer is only found in the district of Lakhimpur in Assam. This species forms small pure consociations in the evergreen climax forests, and its timber is greatly prized. The bark is reddish-brown and exfoliates in large overlapping scales; blaze distinctly laminated, dark-brown, alternating with brown. Both, *S. tumbuggaia* Roxb. and *S. talura* Roxb.,

yield a very excellent timber. The former also exudes a resin which, according to Watt, is one of the common drugs to be found in all the bazaars in India. *S. gratissima* Dyer is a tall tree, with a greyish-brown, deeply fissured bark exfoliating in irregular oblong flakes; blaze conspicuously laminated with darker, alternating with lighter bands. The wood is valued for ship-building in Malaya.

6. *Pentacme* A. DC. *P. siamensis* (Miq.) Kurz is a very large deciduous tree in suitable localities but is shrubby in arid places. It produces its large handsome panicle of flowers when the tree is leafless in spring. The ovate leaves are tomentose. The anthers are quite distinctive as the connective and each loculus of the anthers are appendaged at the tip., i.e. five appendages in all. This species is gregarious in Upper Burma but is found scattered in the *Eng* forests of Lower Burma. It is considered to be the most xerophilous of all dipterocarps. It is deciduous, develops a long tap-root and complicated root-system, it coppices freely and is said to be capable of producing root-suckers (Symington). The timber is heavy and durable and is known as *Engyin* in Burma.

7. *Parashorea* Kurz. There is one species of this genus, *P. stellata* Kurz, in Burma. It is a very large evergreen tree in the evergreen forests of southern Burma. The timber is not durable in contact with the ground but is valuable for constructional purposes. Symington calls this tree *P. lucida* (Miq.) Kurz.

8. *Vatica* Linn. A small genus of two or three species of no importance in forestry. One species, *V. lanceaefolia* Blume, is frequently present as an understorey in the evergreen forests of Assam, where it can grow in very swampy moist localities, as, for example, in the moist *kurkani* areas, characterized by large mounds of worm-casts. In this species the calyx enlarges only slightly and the fruit very much resembles that of *Theaceae*.

35. ERICALES

Shrubs, sometimes epiphytic; flowers actinomorphic, hermaphrodite; ovary superior to inferior with axile placentation; anthers often opening by terminal pores; embryo small; endosperm copious.

65. ERICACEAE 66. VACCINIACEAE

65. ERICACEAE

Trees, shrubs or perennial herbs. Leaves entire or serrate, usually evergreen, alternate or subwhorled, exstipulate. Inflorescence of axillary racemes, or terminal clusters or umbelliform corymbs. Flowers actinomorphic or sometimes slightly

zygomorphic, often beautifully coloured, sometimes dimorphic. Calyx persistent, usually free, 5-, rarely 4- or 6-lobed. Corolla hypogynous, campanulate, cylindric or urceolate, inserted below a fleshy disk, 4-5-lobed; lobes contorted or imbricate. Stamens usually ten, sometimes five, eight or twenty, hypogynous or slightly attached to the base of the corolla, or inserted on the fleshy disk; filaments free or rarely somewhat slightly connate; anthers 2-locular, opening by apical pores or produced upwards into a tube, sometimes dorsally spurred. Ovary superior, 5-locular or rarely 4-16-locular; ovules many on axile placentas which often protrude into the loculi; style cylindric, stigma simple or shortly lobed. Fruit a capsule, 5- or more-locular, sometimes appearing baccate from the adherence of the enlarged succulent calyx. Seeds many, small, angled or compressed, with endosperm; embryo straight.

This large family has several genera in India, all of them confined to temperate habitats.

Key to the genera of *Ericaceae*

- Flowers axillary, usually solitary; small shrubs:
 - Calyx in fruit succulent ... 1. *Gaultheria*
 - Calyx in fruit unaltered:
 - Leaves imbricate ... 2. *Cassiope*
 - Leaves not imbricate ... 3. *Enkianthus*
- Flowers not solitary:
 - Flowers in racemes:
 - Anthers awned ... 4. *Lyonia*
 - Anthers awnless ... 5. *Pieris*
 - Flowers in corymbs, showy ... 6. *Rhododendron*

1. *Gaultheria* Linn. A small genus of shrubs. Two species, *G. nummularioides* D. Don and *G. trichophylla* Royle, are prostrate shrubs of the north-west Himalayas, with dark-blue berries, the former is also said to occur in the Khasi Hills. Two species which grow to shrub size are *G. fragrantissima* Wall. and *G. hookeri* C. B. Cl. and are found in the mountains of eastern India. An oil similar to Canadian Oil of Wintergreen can be distilled from the leaves of the former.

2. *Cassiope* D. Don. *C. fastigiata* D. Don is a small dense shrub with pretty white flowers, forming low mats on moist rocks in the Himalayas at 10,000-15,000 ft. The leaves are small and are somewhat 4-fariously imbricate and appressed. The anatomical structure of these leaves is remarkable. The back or lower surface has a thickened rib with a narrow longitudinal groove which opens into a cavity in the leaf. The upper surface, that is, the surface appressed to the stem, has no stomata. The palisade tissue is found on the lower surface of the leaf from the edge of the thickened portion to the median groove. The

cavity is lined with an epidermis with glandular hairs and stomata, beneath which there is spongy tissue. The plant is by this means adequately protected against rapid transpiration.

3. *Enkianthus* Lour. *E. deflexus* Schm. (*E. himalaicus* Hook. f. et Thoms.) is the only species in India. It is a small tree found in the eastern Himalayas, 8,000-10,000 ft. It has pretty brick-red or orange-red flowers.

4. *Lyonia* Nutt. A genus with a few species found in the Himalayas and the hills between Assam and Burma.

Apices of the filaments appendaged ... *L. ovalifolia*

Apices of the filaments not appendaged ... *L. villosa*

L. ovalifolia (Wall.) Drude [*Pieris ovalifolia* (Wall.) D. Don, *Andromeda ovalifolia* Wall.] is a small deciduous tree with thick brown fibrous bark exfoliating in long narrow strips, deeply furrowed longitudinally, the furrows often spirally arranged. This small tree is common in the Himalayas and in the hills between Assam and Burma, and is usually found on burned grassy slopes associated with *Rhododendron arboreum* and various species of *Quercus*. The wood is of little use for building and is useless as fuel as it does not burn well. The leaves are said to be poisonous to cattle and goats as are those of its close relation *L. villosa* (Hook. f.) Hand.-Mazzt.

5. *Pieris* D. Don. This genus, of which *P. formosa* D. Don is the type, is found in the eastern Himalayas and the Khasi Hills. It has two strong awns projecting backwards from the connective of the anthers. In *Lyonia* Nutt. these two awns are absent but in *L. ovalifolia* there is a pair of weak appendages at the top of the filament. *Lyonia* differs from *Pieris*, to which two of our species had been referred, by the thickened sutures of the capsule and by the awnless anthers.

6. *Rhododendron* Linn. An enormous genus containing many beautiful shrubs and trees, found in many parts of the world, mostly in temperate climates. The more beautiful species are widely cultivated in the gardens of Europe and many hybrids of surpassing beauty have been evolved. The Nilgiri Hills has only one species, very similar in appearance to the well-known *R. arboreum* Sm.; it is called *R. nilagiricum* Zenk. The central and western Himalayas have only four species, of which three are shrubby. The majority of the Indian species are found in Sikkim and to the east, the area north of the Sadiya Frontier Tract being exceedingly rich. The Naga Hills has one or two indigenous species and there are probably many to be described from north-east Burma. The commonest and best-known Indian species is *R. arboreum* Sm., with dark-crimson flowers, which is found all along the Himalayas, usually on burned grassy slopes with species of *Lyonia* and *Quercus*. In the Naga Hills unadministered territory it is often found associated with *Pinus*

insularis Engl. The wood is of no importance and is not even good for fuel.

66. VACCINIACEAE

Shrubs or small trees, often epiphytic. Leaves evergreen, simple, alternate or falsely whorled, entire or serrate, exstipulate. Inflorescence of solitary flowers or of racemes. Flowers actinomorphic, hermaphrodite, often strikingly coloured; pedicels 1-bracteate and often 2-bracteolate, frequently articulate below the ovary. Calyx-tube ovoid, deciduous or persistent, adnate to the ovary, 5-lobed. Corolla gamopetalous, 5-lobed, epigynous, tubular, campanulate or urceolate, deciduous; lobes imbricate. Stamens ten, epigynous, free; anthers 2-locular, opening by apical pores, or produced upwards into two tubes opening by slits. Ovary inferior, 5-locular, often apparently 10-locular; ovules many, on axile placentas; style cylindric; stigma simple. Fruit a berry or drupe. Seeds many, small, compressed, with copious endosperm; embryo straight.

This family contains a number of genera several of which are found in the mountainous parts of India and Burma. At one time considered to be a tribe of *Ericaceae*, it is generally nowadays considered to be worthy of family rank. The majority of the species of *Agapetes* D. Don, *Pentapterygium* Klotzsch, and *Vaccinium* Linn. are epiphytes, often with enormous woody swellings on the roots. The flowers are usually pretty, being mostly red with wavy transverse yellow or green, sometimes black, lines. The berries are often edible. The Cranberry, Whortleberry or Bilberry and the Cowberry are European species of *Vacciniaceae*.

Although the majority of species in this family are shrubby, two common species are trees. *V. leschenaultii* Wight is a small handsome tree with ovate leaves and pink flowers in short close racemes. The bark is thin and brown. The berries are edible. The wood is a light reddish-brown with a pretty silver grain. The tree is confined to the hills of south India and Ceylon. *V. donianum* Wight is very similar to the last-named. The bark is cinnamon-coloured, dark-brown, peeling off in spiral strips; blaze yellow. The flowers, in axillary racemes, are bright-red in colour. It is found in the hills of Assam and Upper Burma.

36. GUTTIFERALES

Trees or shrubs with resinous or coloured juice; flowers actinomorphic, hermaphrodite, monoecious, dioecious or polygamous; ovary superior, 1-many-locular; stamens many, often connate into bundles; embryo straight, often large; endosperm present or absent.

67. HYPERICACEAE

Herbs or shrubs with yellowish juice. Leaves opposite, usually gland-dotted, exstipulate. Flowers hermaphrodite, usually terminal, rarely axillary, arranged in cymose panicles or solitary, actinomorphic, usually yellow. Sepals and petals usually five each, imbricate. Stamens indefinite, often gathered into three or five bundles, or all the filaments connate. Anthers versatile, 2-locular, opening lengthwise. Ovary of 3-5 carpels, 1- or 3-5-locular. Ovules few or many on axile or parietal placentas. Fruit capsular or baccate. Seeds without endosperm.

Many species of *Hypericum* Linn. are to be found in hills and plains. Most of them are herbaceous but several are bushes. The large yellow flowers, stamens collected into bundles and the pellucid-dotted leaves are easy means of identification. One genus reaches tree size in India and Burma, namely *Cratoxylon* Blume. There are one or two species in India and Burma which are easily recognizable. The flowers are pink, red or white, typically hypericaceous and the leaves are pellucid-punctate and the juice is yellow. It is rather a genus of Malaya, Cochin-China and Burma than of India. *C. formosum* Benth. et Hook. f. is a small tree found in the Andamans. It has a reddish blaze which exudes a clear yellow juice and a pleasant smell like that of a mango. When young the stem of this species is covered with woody spines very similar to those seen in *Flacourtia*.

68. GUTTIFERAE

Trees or shrubs with resinous white or yellowish juice. Leaves opposite, shining, coriaceous, exstipulate. Inflorescence of axillary or terminal panicles, or of few-flowered cymes or often of solitary axillary flowers. Flowers monoecious, dioecious, rarely hermaphrodite and polygamous. Sepals 2-6, free, imbricate. Petals 2-6, rarely more, hypogynous, contorted or imbricate. Male flowers; stamens usually numerous, inserted on the receptacle; filaments free or variously connate below, or into bundles opposite the petals, sometimes long and filiform; anthers 2-locular, opening by longitudinal slits; rudimentary ovary sometimes present. Female flowers; ovary seated in a fleshy disk, 2 - many-locular, rarely 1-locular; stigmas as many as the loculi, coherent and peltate or radiating; ovules 1 - many, on the inner angle or erect and basal. Fruit often a large drupe or berry, sometimes indehiscent, sometimes septicidal. Seeds often arillate, exalbuminous. Embryo large, straight.

This is a very easy family to recognize in the forest. The leaves are very leathery, opposite and sometimes with very numerous parallel nerves. Most species when blazed exude a white or yellowish juice. The species are inhabitants of

the evergreen climax forests of eastern India and the Deccan Peninsula.

The following key will be found useful for distinguishing genera in the field.

Trees with white or yellow juice in the bark:

Leaves narrowly oblong-elliptic or narrowly elliptic:

Glaucous-white below; style 1, stigma peltate 1. *Mesua*

Not glaucous-white below; styles 2, stigmas acute

6. *Poeciloneuron*

Leaves broad, not glaucous beneath:

Trees often with horizontal branches; sepals 5

2. *Garcinia*

Trees without horizontal branches; calyx entirely closed in the bud, bursting irregularly ... 3. *Ochrocarpus*

Trees without coloured juice in the bark:

Leaves without close parallel secondary nerves 4. *Kaya*

Leaves with numerous very close parallel secondary nerves:

Style 1; leaf-tip rounded

... 5. *Calophyllum*

Styles 2; leaf-tip pointed

... 6. *Poeciloneuron*

1. *Mesua* Linn. One species, *M. ferrea* Linn., in India. This evergreen tree is widely spread in India, being found in climax forests in Assam, Burma, Bengal, Bombay State, Madras State, etc., apart from which it is often planted as an ornamental tree. In these forests it often forms consociations which may cover a considerable area. The glossy leaves, green above, glaucous-white below, and the large white fragrant flowers, are very pleasing. In spring, when the leaf-buds burst, the young leaves are almost scarlet or even white in colour and as they grow older pass through many colour changes to the dark glossy-green of the mature leaves. A deep blaze on the trunk shows sparse drops of a thick white juice. The timber is extremely durable but very heavy and hard to work. It is sometimes known as Ironwood in Assam. This tree is often fluted at the base and old specimens exhibit typical plank-buttresses.

2. *Garcinia* Linn. This genus is a very large one and it is not possible to indicate all the species here. In the forest the *Garcinias* appear as symmetrical medium-sized straight-stemmed trees with horizontal branches. The flowers of most wild species appear to be nocturnal, opening at sunset and exhaling a powerful and rather overpowering odour suggestive of a highly seasoned gravy (Corner). The bark when blazed exudes a juice which varies in colour from deep-gamboge to pale-yellow or almost white. The quantity of juice exuded is sometimes of use in separating species. The fruit is often pulpy and some are edible; for example, the mangosteen is the fruit of *G. mangostana* Linn. The timber is useless. The fruit of *G. cowa* Roxb. is considered

to be of use in dysentery cases in Assam. The tree *G. morella* Desr. is the source of the dye 'camboge' which was formerly extensively used for colouring silk. The tree is found in Kanara and the dye is obtained by slashing the bark and collecting the exudate. The fruits of *G. cambogia* Desr. are quite distinctive; they are about the size of an orange and deeply grooved. Slices of the fruit are dried in the sun and are very palatable.

3. *Ochrocarpus* Thouars. The only species of this genus which is of importance is *O. longifolius* Benth. et Hook. f., an evergreen tree which is quite common in the evergreen forests of the Western Ghats in Bombay State and Malabar. It is apt to be mistaken for *Garcinia* unless flower-buds are present. *Garcinia* has a calyx of separate sepals, while *Ochrocarpus* has one of combined sepals, which burst irregularly as the flower opens. The timber is of no account but the flower-buds are used locally as a dye and the open flowers are used in Hindu ceremonies.

4. *Kayea* Wall. A genus with a few species found in Assam, Bengal and Burma in the evergreen climax forests. The Assam species, *K. assamica* King et Prain, is remarkable for its depressed globose fruit having an outer hard shell which is composed of the accrescent sepals (cf. *Dillenia*). The timber of this species is held in high regard in Assam and is largely used for house construction. The fruit is said to be used to poison fish. Incidentally, the cotyledons are full of a creamy milky juice. The Bengal species is *K. floribunda* Wall.

5. *Calophyllum* Linn. This genus is an extremely easy one to spot in the forest provided one can obtain the leaves. This is sometimes a matter of some difficulty as the trees are very often of enormous height. Leaves can, in most cases, be picked up from the forest floor. Their coriaceous texture, rounded tip, combined with the very numerous parallel secondary nerves serve to distinguish this genus from all others. The species included in this genus are all evergreen trees with handsome foliage, and are at home in the evergreen climax forest of India and Burma. The best-known of the species is perhaps *C. elatum* Bedd. (*C. tomentosum* T. Anders.), the Poon tree of the western coast. It is often called the Spar tree because many hundreds of years ago the Moors used to come to India to get this tree for the masts of their dhows: the price paid was the number of rupees laid edge to edge along the length of the spar. This species is a tree of immense height and girth (150 ft. tall, 15 ft. girth) in the forests of the Western Ghats. The vertically fissured yellowish bark makes this tree easily recognizable. *C. inophyllum* Linn., the Alexandrian Laurel, is largely cultivated on the western coast, not only for its handsome foliage, but also for its valuable fruit. It yields an oil which is used in medicine and for various other purposes.

6. *Poeciloneuron* Bedd. This genus contains two species only, *P. indicum* Bedd. and *P. pauciflorum* Bedd., both of which are indigenous in the southern parts of the Deccan Peninsula. They are inhabitants of the evergreen climax forests of those parts and grow into fine tall trees. The timber is considered to be valuable. The leaves are coriaceous, pointed at the tip, and possess many closely parallel nerves. *P. indicum* Bedd. is one of the more important timber-trees of Mysore. A characteristic feature of this tree is the production of curved stilt roots which become flattened as they grow older and take on the form of buttresses. From this feature alone this tree can be picked out in high forest. Two varieties of the tree are found in the Mysore forests, one of which develops a black heartwood while that of the other is red. Apparently there is no decisive taxonomic difference between the two but there are a good many differences in habit, among which may be mentioned that the bark of the variety with black heartwood is darker than the other.

37. MYRTALES

Trees ; flowers hermaphrodite, actinomorphic ; ovary inferior, syncarpous, stamens numerous ; anthers sometimes opening by pores ; embryo straight, curved or circular ; endosperm present.

69. MYRTACEAE 70. LECYTHIDACEAE
 71. MELASTOMATACEAE 72. COMBRETACEAE
 73. RHIZOPHORACEAE 74. SONNERATIACEAE
 75. PUNICACEAE

69. MYRTACEAE

Trees or shrubs. Leaves simple, entire, coriaceous, opposite, occasionally alternate, pellucid-punctate, exstipulate or with minute stipules. Inflorescence sometimes of solitary flowers in the leaf-axils, but generally in cymose, more rarely racemose, branched panicles. Flowers hermaphrodite, actinomorphic, or polygamous by abortion. Calyx-tube more or less adnate to the ovary, 3- or more-lobed; lobes valvate or imbricate or splitting irregularly. Petals 4-5, rarely six or none, inserted on the margin of the disk lining the calyx-tube, free and imbricate or connivent into a cap or operculum. Stamens numerous, inserted with the petals on the margin of the disk lining the calyx-tube, 1- or more-seriate, inflexed in the bud or twice-folded or straight; filaments filiform or linear, free, or more or less monadelphous at the base or polyadelphous in bundles opposite the petals; anthers 2-locular, opening longitudinally by slits; connective sometimes tipped by a gland. Ovary inferior, syncarpous, 1 - many-locular, with axile, rarely parietal placentation; ovules

few. Fruit usually fleshy, sometimes a capsule, indehiscent or loculicidally dehiscent. Seeds without or with little endosperm. Embryo straight.

A family containing few genera but many species. It is easily recognized by the opposite pellucid-punctate leaves (alternate in *Eucalyptus*) which are aromatic when crushed.

Key to the genera of *Myrtaceae*

Fruit baccate:

Leaves with 3-5 ribs ... 1. *Rhodomyrtus*

Leaves penninerved:

Calyx closed in the bud; lobes in the flower valvate;
ovary many-locular ... 2. *Psidium*

Calyx open in bud; ovary usually 2-locular ... 3. *Eugenia*

Fruit dry, loculicidally splitting at the top:

Petals calyptrate ... 4. *Eucalyptus*

Petals not calyptrate:

Flowers in axillary spikes ... 5. *Melaleuca*

Flowers in proliferous spikes ... 6. *Callistemon*

1. *Rhodomyrtus* DC. *R. tomentosa* Wight is a hoary-tomentose shrub found above 5,000 ft. in the Nilgiris. The leaves are 3-5-ribbed and resemble those of *Melastoma* or *Osbeckia*, but in the latter the flowers are terminal while those of *Rhodomyrtus* are axillary. The pink flowers are handsome and the fruit makes an excellent jam and is also good in tarts. The bark is thin, red and papery. The branches and stem make good walking-sticks.

2. *Psidium* Linn. *P. guajava* Linn., the Guava, is known throughout the tropics, where it is cultivated for the sake of its fruit. It is said that its native home is America and that the Spaniards introduced it into other countries. It has run wild in many parts of India and deteriorates rapidly if not cared for. The leaves contain tannin and are medicinal.

3. *Eugenia* Linn. This is a very large genus which has been split up into three genera which are fairly distinct from one another. All *Eugenias* can be spotted in the forest by their gland-dotted opposite leaves which also have a very definite intramarginal nerve.

The three genera, which are found in India, are separated by the following key.

Calyx-tube produced beyond the ovary; flowers in cymes; stamens bent back inwards in bud at the middle:

Calyx-tube with a thickened staminal disk at the mouth;
flowers large; petals falling free ... *Jambosa*

Calyx-tube without a thickened staminal disk; flowers
usually small; petals falling free or more usually as a
calyptrum ... *Syzygium*

Calyx-tube not produced beyond the ovary; flowers solitary or fascicled or in short racemes; stamens erect or incurved
Eugenia

The genus *Eugenia* (*sensu lato*) is a very large one, nearly one hundred species being found in India alone. The best-known species in India is *Syzygium cumini* (Linn.) Skeels (*Eugenia jambolana* Lam.), the Jaman, which is largely planted along road-sides and in gardens for shade and also for the fruit. The bark is thick, light- to dark-grey or brown in colour; blaze red. The wood is considered to be an excellent fuel and is also used for rough work. *Syzygium jambos* (Linn.) Alston (*Jambosa vulgaris* DC.) is the *Gulab Jaman* or Rose-Apple of Indian gardens. One tree which is not indigenous, but which is sometimes planted, is *E. aromatica* O. Ktze. (*E. caryophyllata* Thunb.), the Clove tree, a native of the Moluccas. The flower-buds are the cloves of commerce.

4. *Eucalyptus* L'Hérit. This is an Australian genus of ever-green trees, with very aromatic leaves which are alternate on the older shoots. The juvenile leaves are usually opposite and sessile and are generally very different in appearance from the older. The older leaves hang down vertically and give the trees a very distinctive appearance. A very large number of species have been introduced into India and some of them have done well, notably *E. globulus* Labill., which has largely been planted on the Nilgiris.

5. *Melaleuca* Linn. *M. leucadendron* Linn., the Cajeput Oil tree, is a common tree in gardens and is often confused with *Eucalyptus* and the phyllode-bearing species of *Acacia*. From the former it can be distinguished by the longitudinal nerves in the leaves and from the latter by the pellucid glands.

6. *Callistemon* R. Br. Several species of *Callistemon* are cultivated in gardens. They are interesting plants because of the inflorescence which is a proliferous spike. The flowers have very long stamens which are brightly coloured. The small dry fruits remain for a long time clustered on the branches far below the terminal cluster of leaves. *C. viminalis* and *C. rigida* are two exotic trees very commonly cultivated in Indian gardens. The former produces very large quantities of nectar and is much sought after when in flowers by bees.

70. LECYTHIDACEAE

Trees or shrubs. Leaves alternate, simple, often large, not pellucid-punctate, exstipulate. Inflorescence of racemes or spikes or of solitary or clustered flowers. Flowers often showy, sometimes large, actinomorphic or zygomorphic, hermaphrodite. Calyx adnate to the ovary, 4-6-lobed; lobes valvate or slightly imbricate. Petals 4-6, free or united below. Stamens numerous,

several-seriate, united at the base into a thin or thick, fleshy ring, the stamens of the outer and inner series sometimes without anthers, in certain genera the stamens are all on one side and filaments connate; filaments subulate, often coloured; anthers 2-locular, dehiscent by longitudinal slits. Ovary inferior, 2-6-locular; ovules 1 - several in each loculus, anatropous, ascending, horizontal or pendulous. Fruit woody or fleshy, indehiscent or operculate at the apex. Seeds without endosperm. Embryo divided or entire.

In Brandis, *Indian Trees*, and in *Genera Plantarum* this family is included in *Myrtaceae* but there can be no doubt that the two are better kept apart. The main point of difference is of course the structure of the leaves, which in *Myrtaceae* possess bicollateral vascular bundles and numerous spherical glands containing ethereal oil. These structures are absent in *Lecythidaceae*, which has a special anatomical feature of its own in the leaves. This character is a series of cortical bundles which run up as separate strands in the petiole and remain distinct in the midrib and largest lateral veins (Rendle).

Three genera of this family are found in India. The following key distinguishes them.

- | | | |
|---|-----|------------------------|
| All stamens fertile; fruits angled | ... | 1. <i>Barringtonia</i> |
| Some stamens infertile; fruit not angled: | | |
| Stamens of the inner series without anthers | | 2. <i>Planchonia</i> |
| Stamens of the inner and outer series without anthers | | 3. <i>Careya</i> |

1. *Barringtonia* Forst. A genus of small trees frequenting marshy places and the seashore where the soil-water is not too brackish. The flowers of most of the species of the genus are nocturnal and do not open until the sun is sinking, at which time most of them are fragrant. The germination of the species is peculiar, as pointed out by Troup. The shoot is developed from one end of the fleshy embryo and the long tap-root from the other. The fleshy portion of the embryo consists of two concentric homogeneous masses of cellular tissue, separated by a thin layer of delicate cells. It much resembles the concentric rings in a carrot. Only a few of the species are of interest, but the following is a key to all the species found.

Calyx closed in the bud, splitting irregularly:

Fruit angled:

- | | | |
|---------------------------|-----|------------------------|
| Flowers purple | ... | <i>B. macrostachya</i> |
| Flowers not purple: | | |
| Flowers sessile | ... | <i>B. pendula</i> |
| Flowers pedicelled: | | |
| Flowers 3 in. in diameter | ... | <i>B. asiatica</i> |
| Flowers 1 in. in diameter | ... | <i>B. racemosa</i> |
| Fruit conically pyramidal | ... | <i>B. conoidea</i> |

- Calyx 3-4-cleft; lobes slightly imbricate:
 Flowers pedicelled in slender racemes *B. acutangula*
 Flowers sessile on a thick rhachis:
 Flowers greenish; calyx-lobes blunt *B. angusta*
 Flowers white or rose-coloured; calyx-lobes acute *B. pterocarpa*

Most of these species are found in Burma and only a few are of any interest.

B. asiatica Kurz (*B. speciosa* Forst.) is a tree of moderate size found in the Andamans and on the west coast of Burma. The fruits of this species are used in many places to intoxicate fish. It is a conspicuous seashore tree from its dark-green glossy leaves with purple petiole and midrib. The flowers are handsome; the petals are white and the stamens, up to 3.5 in. long, pink.

B. acutangula Gaertn. This is an inland evergreen species which sometimes reaches moderate size. It is common on both sides of the Peninsula, extending into Assam and Burma. The bark of this tree is rich in tannin and it is also used to intoxicate fish. Its usual habitat is in swamps, and, in the Surma Valley, the tree goes regularly under water during the flood season, without, apparently, taking any harm therefrom. The wood is of some use locally. It is a favourite garden-tree, where the long racemes of flowers with long pink stamens are much admired.

A number of the other species are of use medicinally.

2. *Planchonia* Bl. A small genus of trees of which only one species is found in the Andamans. This species is *Planchonia valida* Bl. (*P. andamanica* King), a large deciduous tree with dark-green foliage. Before the leaves fall they turn bright-red and render the tree conspicuous and easily recognized. The flowers are white, tinged with pink, about 2 in. long. The timber is used locally for houses, and is known as Red Bombwe in the trade.

3. *Careya* Roxb. A genus with two species in India, of which one is a widespread tree and the other a prostrate shrub confined to the savannahs of Bengal, Assam and Burma. *C. arborea* Roxb. is a moderate-sized to large deciduous tree with large obovate leaves turning bright-red before they fall. The bark is fissured and dark-grey in colour with a red fibrous blaze. The large pink and white flowers appear when the tree is leafless and are succeeded by large pulpy fleshy fruits 3 in. in diameter. This tree is extremely fire-resistant and flourishes in the savannah of the drier and wetter parts of India. *C. herbacea* Roxb. is a peculiar species which is very similar to *C. arborea* except that its flowers are purple and it has the habit of an undershrub. This species has caused some alarm in Bengal in recent years because it is usurping grazing land with the aid of fire.

Couroupita guianensis Aubl., the Cannonball tree, is an inhabitant of tropical South America but is sometimes found cultivated in gardens for the sake of its extraordinary flowers and fruits. The flowers are very showy and are borne in racemes on the trunk. There are six sepals, and six broad petals which are yellow on the outside, pink inside and veined with apricot-yellow. The stamens are in two sets: one series forms a ring or cup in the centre of the flower while the other series is seated on the under-surface of a thick flap which projects up above the flower and is attached to the staminal ring below. The stamens on this flap are fertile and magenta in colour. The fruits are perfect spheres about 8 in. in diameter. When ripe they have a disgusting odour. The tissue of the petals when broken turns from white to blue on exposure to the air.

71. MELASTOMATACEAE

Trees, shrubs or herbs. Leaves opposite or whorled, sometimes spotted or variegated (*Sonerila*), usually with 3-9 longitudinally parallel nerves, united by parallel transverse nerves, rarely pinnately nerved, sometimes only the midrib evident, exstipulate. Inflorescence of terminal solitary flowers, or cymes or long panicles, or in umbelliform cymes. Flowers usually very showy, actinomorphic. Calyx tubular, free or adnate to the ovary, 4-5-lobed; lobes imbricate or rarely valvate. Petals 4-5, deciduous, free, rarely united at the base, brightly coloured, alternate with the calyx-lobes, twisted to the right in the bud. Stamens the same number as or double the number of the petals, sometimes all equal and fertile, sometimes those opposite the petals sterile; filaments free, inflexed in the bud. Anthers 2-locular, sometimes of two kinds in the same flower, basifixed, opening by a single terminal pore; connective often appendaged. Corona usually present between the petals and stamens. Ovary inferior, 2 - many-locular, rarely 1-locular (*Memecylon*); ovules numerous, axile. Fruit capsular, dehiscent loculicidally, or a berry. Seed minute, without endosperm.

This family is not of great importance to the forester, but since numerous melastomataceous species are found in his forests and grasslands it is necessary to know something of it. *Melastomataceae* is closely allied to *Myrtaceae* but differs primarily from it by the absence of the characteristic spherical glandular cavities in the tissues of the latter. The leaves too, with 3-9 longitudinal nerves, are characteristic of *Melastomataceae*, but it will be recollected that *Rhodomyrtus* and *Leucadendron* (*Myrtaceae*) and some *Lauraceae* have also longitudinal nerves in the leaves, and indeed, the leaf of the former is typically melastomataceous. The leaves of one of the small tree genera, *Memecylon*, although very distinctive, are different from those of other genera in the family. They are coriaceous and the secondary nerves are very obscure,

often quite indistinguishable so that the leaf appears to have a midrib only. The young leaves of the species of this genus may be pink, purple or deep-blue.

Many species of *Melastomataceae* are worthy of cultivation in gardens on account of their gaily coloured flowers. *Tibouchina* Aubl., a South American genus, gives us a species, *T. semi-decandra*, with very large purple flowers, frequently cultivated in Shillong and other hill-stations. *Melastoma malabathricum* Linn. is a very common shrub in the plains and hills of India and is sometimes called *Rhododendron* or *Azalea*.¹ *Osbeckia* is a similar genus but with stamens of one kind only; *Melastoma* has dimorphous stamens. The genus *Memecylon*, with many species, is very common on the western coast, there being eighteen species in Madras State alone. The flowers are very small, usually arranged in axillary fascicles or paniced cymes or umbels, but of a most delightful pale- or deep-blue colour, which combined with a calyx, which is often red, are very pretty. One species, *M. edule* Roxb., has edible fruits and the leaves are used to dye cloth yellow. In fact, most species contain a yellow dye in their leaves, which when dry are yellow in colour.

72. COMBRETACEAE

Trees or shrubs, erect or climbing. Leaves opposite or alternate, simple, entire, coriaceous; stipules absent. Inflorescence spicate or racemose. Flowers hermaphrodite, actinomorphic, usually small. Calyx-tube adnate to the ovary, 4-5-lobed; lobes valvate in the bud; persistent or deciduous. Petals absent, or as many as the calyx-lobes and alternate with them, valvate or imbricate in the bud. Stamens 4-10, rarely more, inserted with petals, sometimes alternate with them; filaments inflexed in the bud; anthers introrse, 2-locular, dehiscing by longitudinal slits, versatile, didymous. Ovary inferior, 1-locular, crowned by a sometimes fleshy disk; ovules 2-6, suspended from the apex of the loculus by long funicles, anatropous; style long, filiform. Fruit leathery or drupaceous, 1-seeded, 2-5-angled, the angles often forming broad membranous wings (*Terminalia*).

This family is of importance to the forester, as it contains a number of valuable timber-trees. A number of species are rich in tannin, which is found in the bark, leaves and fruit. When dissecting the flowers of this family, students are very apt to go astray.

If the flowers are pulled off the inflorescence in a careless manner the ovaries may be left behind on the axis or branches, leading students to believe that its flowers are unisexual. The

¹ It is, or was, the principal shrub on the so-called *Azalea Walk* in Shillong, a fact which comments loudly on the deplorable lack of botanical knowledge of Shillong residents.

ovary being inferior is often taken to be the pedicel of the flower. Actually its 1-locular ovary with a pendulous funicled ovule is very characteristic.

The following is a key to the genera found in India.

Petals 0:

Calyx-limb deciduous; erect trees or shrubs:

Flowers in spikes or racemes ... 1. *Terminalia*

Flowers in capitate heads ... 2. *Anogeissus*

Calyx-limb accrescent in fruit; straggling herbs

3. *Calycopteris*

Petals 4-5:

Calyx-limb persistent; leaves alternate; trees and shrubs

4. *Lumnitzera*

Calyx-limb deciduous; leaves opposite; climbers:

Calyx-tube produced beyond the ovary 5. *Quisqualis*

Calyx-tube not or only shortly produced 6. *Combretum*

1. *Terminalia* Linn. A large genus which is of great importance to the forest officer because many species yield valuable timber. Most species of this genus have glands at the top of the petiole.

There are a number of species in India which can be separated by the following key.

Fruit not winged, ovoid or sub-compressed:

Flowers in simple spikes; leaves clustered at the ends of the branches, alternate, obtuse:

Leaves cordate at the base; fruit 2-ridged when dry

T. catappa

Leaves cuneate or rounded at the base; fruit more or less 5-angled:

Fruit subglobose, very faintly 5-ridged when dry, minutely brown-tomentose

T. bellerica

Fruit obovoid, faintly 5-ribbed when dry, glabrous

T. pallida

Flowers in simple spikes or short terminal panicles; leaves not clustered at the ends of the branches, opposite or sub-opposite:

Fruit minutely brown-tomentose ... *T. gella*

Fruit glabrous, shining:

Leaves obtuse and apiculate, up to 7 in. long; spikes nearly glabrous; fruit obovoid, faintly angled, 1.5 in. long ... *T. chebula*

Leaves acuminate, up to 4 in. long; spikes rusty-puberulous; fruit ovoid, covered with round spots, up to 1.75 in. long *T. travancoriensis*

Fruit with 3-5 equal hard angles or wings:

Fruit with hard woody wings or angles, often notched near the top, marked with oblique upward-curving striations

T. arjuna

Fruit with thin coriaceous or papery wings, usually rounded at the top, and marked with straight striations more or less at right angles to the axis:

Fruit glabrous:

Leaves hairy beneath. Twigs and inflorescence hairy
T. alata

Leaves glabrous. Twigs and inflorescence glabrescent
T. crenulata

Fruit generally minutely or softly grey- or short-tomentose ... *T. coriacea*

Fruit with 3 unequal wings:

Wings 1 long, 2 short ... *T. paniculata*

Wings 2 long, 1 short ... *T. myriocarpa*

Fruit with two equal wings ... *T. bialata*

T. catappa Linn. This species is a tall deciduous tree in its native home which is on the sandy coasts of Malaysia and in the Andamans. It is largely cultivated outside its home in India and Burma, particularly round monasteries, both for ornament and for the sake of its edible fruits. It is known as the Indian Almond tree and (according to Troup) as White Bombwe in the Andamans. Parkinson, on the other hand, says this name is given to *T. procera* Roxb. which is similar to *T. catappa* and is considered synonymous with it by Troup. Apparently in the Andamans these two trees are often confused but Parkinson says that the leaves of *T. procera* are obovate in shape, tapering into the petiole, and the fruit is not compressed or keeled. *T. catappa* has the leaves auricled or cordate at the base and the fruit is distinctly compressed or keeled. Both are tall deciduous trees, but *T. catappa* has not the long clean bole of the other. It is very easy to spot *T. catappa* from its smooth grey bark, and large glabrous shining leaves which turn red before falling in the hot season. This tree is often confused with *Calophyllum inophyllum* but there should be no difficulty in distinguishing them at a glance. The secondary nerves of the leaves of *Calophyllum* are very close together and parallel, those of *Terminalia* are widely separated. The bark of this tree contains tannin.

T. bellerica Roxb. A large deciduous tree with a very straight tall bole, buttressed at the base. The bark is bluish or ashy-grey covered with numerous fine longitudinal cracks; blaze yellow. It is found in the deciduous forests throughout India and Burma, but not in the arid regions. It is a common tree in sal forest. The timber, which is known as Barbera in the trade, is used for house-building after being steeped in water, which, according to Gamble, makes it more durable. The fruits yield an inferior tanning material.

T. pallida Brandis. Little is known of this small sub-evergreen tree which is found in the arid regions of Madras State. It

is somewhat similar in appearance to *T. chebula* and its wood and fruit are put to the same uses as that of the latter species.

T. gella Dalz. According to Gamble, this is a tree of large size with a large velvety fruit, coriaceous leaves and flowers in dense spikes. It is indigenous in Madras State.

T. chebula Retz. is a moderate-sized to large deciduous tree. The bark is dark-brown, often longitudinally cracked, exfoliating in woody scales. The leaves of this species have a pair of large glands at the top of the petiole. The fruits, when dried, form the *Myrabolans* of commerce. The ovoid, glabrous and faintly angled fruits are about one inch long and are collected when they begin to turn yellow. The fruit contains tannin, sometimes as much as 46 per cent, but the amount varies according to the origin of the fruit and also the time of the year at which it is collected. The timber is not of any value.

T. travancoriensis Wight et Arn. This species is a very large forest tree with a smooth pale-brownish bark. The fruit is ovoid, yellowish-brown in colour, and covered with prominent lenticels, a character which separates it from all other species.

T. arjuna Wight et Arn. A large evergreen tree with a large spreading crown and drooping branches. The bark is very thick, grey- or pinkish-green, smooth, exfoliating in large thin irregular sheets; blaze pink. The tree resembles *T. alata* except for the smooth bark, the narrower wings to the fruits and the fact that it is characteristic of the banks of streams (Troup). The tree is common throughout the greater part of the Indian Peninsula along the banks of watercourses and is often planted as an avenue tree. The timber is brown with dark streaks, very hard, and is used for building, making carts and other purposes. The flowers, which appear in April-May, are strongly honey-scented. It is known to the trade as Arjun. The bark is used for tanning and Troup remarks, 'a special blazing instrument is used which strips off flakes of cortex without penetrating to and damaging the cambium, and within two years the stripped patches are covered with a thick new growth of cortex slightly lighter in colour than the original bark; if the cambium is injured the wood blackens and no regrowth of cortex takes place'. This species is easily recognized by the fruit with five hard winged angles.

T. alata Heyne. Parkinson points out¹ that this species has two varieties of which var. *typica* is *T. tomentosa* Wight et Arn. and var. *tomentosa* is the *Pentaptera tomentosa* of Roxburgh.

T. alata Heyne var. *typica* C. B. Cl. is found in an area extending from the Ganjam district to the Vindhya mountains.

T. alata Heyne var. *tomentosa* C. E. Parkinson is found in

¹ In *Indian Forest Records* (Bot.), vol. I, Pt. I, p. 14.

an area comprising the foot-hills, tarai and bhabar from the Punjab eastwards to Assam and extending into northern Burma.

T. alata Heyne is a large deciduous straight-stemmed tree attaining 100 ft. or more in height. The bark is dark-grey to black in colour, with deep vertical fissures and transverse cracks which cause it to exfoliate in thick irregular flakes; blaze red. The tree is of great importance in the timber trade, where it is known under the name of laurel. Silviculturally it is regarded as suitable for afforesting clayey soil. The young branches and leaves are considered to be the best leaf-manure for the supari gardens of North Kanara in Bombay State.

T. crenulata Heyne is a large deciduous tree with a dark-grey furrowed bark exfoliating in rectangular flakes. The wood is dark-brown, streaked with black, and is considered to be useful for building and agricultural purposes. This tree is found in southern and western India as well as in Upper and Lower Burma.

T. coriacea (Roxb.) Wight et Arn. is a tree growing on rocky or gravelly soil and possessing a bark which is dark coloured, and cracked like a crocodile's skin. It is found in the drier and hotter parts of Madras State and of central India. One variety, var. *peguensis* C. E. Parkinson, is found only in the Pegu Yoma forests of Lower Burma.

T. paniculata Roth. This species is a large or very large deciduous tree with a dark-brown, rough bark with numerous shallow longitudinal and transverse fissures; blaze red, mottled. This tree is found in deciduous forests of the western districts of Bombay and Madras States. It is said to be the commonest tree in Travancore, often forming, according to Bourdillon, 40-60 per cent of the trees of the deciduous forests up to 2,000 ft. The wood, known in the trade as Kindal, is light-brown and hard but has little other than local use. The bark contains much tannin. This species is easily recognized by its characteristic rusty-puberulous fruit.

T. myriocarpa Heurck. A gigantic deciduous or semi-deciduous tree with long drooping branches. The bark is rough, dirty-grey or greyish-brown, exfoliating in large longitudinal flakes. This tree is found in a tract extending from Nepal eastwards into Assam and Upper Burma, ascending in the hills to 5,000 ft. It is decidedly gregarious in Assam on light alluvial soil and can be got to regenerate itself with ease in such places. The tree is very striking in flower or fruit. The whole tree seems to be covered with the tiny white flowers which turn red as the small winged reddish seeds make their appearance. The wood is rather perishable out of doors but is considered to be very valuable for plywood. The trade name of this tree is Hollock.

T. bialata Steud. This tree reaches very large dimensions in Burma and the Andamans, where it furnishes the valuable

wood known as White Chuglam or Indian silver-grey wood. When in fruit it is easily recognized from the achene which has only two broad papery wings. The bark is light-brown, smooth and finely fissured. The timber is grey, beautifully mottled and moderately hard. It takes a magnificent polish and looks, when finished, like oak.

2. *Anogeissus* Wall. A small genus of trees usually found in the drier parts of India. Some species are economically important. They can be easily distinguished from other species of the *Combretaceae* by the globose heads of flowers or fruits, the latter terminating in a beak which represents the remains of the calyx-tube.

There are four species in India.

Beak shorter than the fruit ... *A. pendula*

Beak as long as or longer than the fruit:

Branchlets and underside of leaves clothed with long silky hairs. Fruits 0.75 in. in diameter ... *A. sericea*

Branchlets and underside of leaves not clothed with long silky hairs, at most softly pubescent; fruit at most 0.66 in. in diameter:

Leaves elliptic or sub-orbicular, up to 3 in. long, obtuse at the apex; flower-heads usually in cymes; wings of fruit entire ... *A. latifolia*

Leaves elliptic-lanceolate, up to 2.5 in. long, acute at the apex; flower-heads usually solitary; wings of fruit dentate ... *A. acuminata*

A. pendula Edgew. A small tree which is quite different from the other species, being distinguished by its graceful pendulous branches and crooked bole. This tree is typically gregarious and often forms pure forests. It is essentially a tree of hot arid places and is found in Bundelkhand, Rajputana and the southern districts of Uttar Pradesh. The leaves contain tannin.

A. sericea Brandis. This species is a moderate-sized tree with silky branchlets and silky under-surface of the leaves. Otherwise it is not very different from *A. acuminata*, except that while the latter has solitary flower-heads on short bracteate peduncles, this species has solitary heads on long peduncles which, moreover, often bear a number of leafy bracts. Notwithstanding these differences it is a matter of opinion whether *A. sericea* is a good species or not.

A. latifolia Wall. is a moderate-sized to large deciduous tree. The bark is thin, smooth, greyish-white, exfoliating in thin rounded scales which leave shallow depressions. The blaze has an outer chlorophyll layer, then brown-pink and inside brown. This tree is found in the foot-hills of the Himalayas from the Ravi to Nepal and in central India and the hills of south India

up to 4,000 ft. It is characteristic of the deciduous forests usually of a dry type, but it is also found in sal forest. In the Siwaliks it grows gregariously associated with *Buchanania latifolia*, *Ougeinia dalbergioides*, *Terminalia alata*, etc. The wood is extremely tough and is much in demand for articles where this character is a desideratum. The trade name of the wood is Axle-wood. The leaves contain tannin and the bark contains a gum which is used for calico printing. The leaves turn a red or a copper colour in the cold weather and are shed at the beginning of the hot weather. Pellucid glands are visible in the leaf from above.

A. acuminata Wall. is a large handsome deciduous tree with a tall straight bole found in an area extending from central India, south of the Gangetic Plain, eastwards to Burma. It is plentiful in the mixed deciduous forests of the area and can penetrate into low-lying swampy ground. The bark is dark to black, cracked, with a red blaze. Pellucid dots are visible in the leaf. The wood of this tree is thought to be inferior to that of the last named species. Its trade name is Yon.

3. *Calycopteris* Lam. This genus is represented by one species, *C. floribunda* Lam., a scandent shrub which has a wide distribution extending from the west of the Indian Peninsula to Assam and even into Burma. The leaves are covered on the under-surface with minute peltate scales resembling those of species of *Combretum*. The presence of petals in *Combretum* easily separates that genus from *Calycopteris*. It is a well-known fact in the forests of Bombay State that this climber is capable of giving large quantities of water which only contain a minute quantity of solids.

4. *Lumnitzera* Willd. *L. racemosa* Willd. is a small tree with a dark-coloured rough bark peeling off in flakes and white flowers in axillary racemes. It is found on the coasts of India and Burma.

L. coccinea W. et A. is a similar but much larger species with scarlet flowers in terminal racemes. These are both species of tidal forests. The root-system is superficial and the horizontal roots send up knees into the air. At first sight these species might be taken for two other mangrove species, *Scyphiphora* or *Aegiceras*. *Scyphiphora* has opposite, distinctly petiolate, round leaves, the terminal pair of which are sticky and closely appressed. In *Aegiceras* the leaves are alternate, shortly petioled, twice as long as broad, with entire, slightly reflexed margins. The leaves are obovate or spatulate, about three times as long as broad in *Lumnitzera*. The wood of these species is said to be durable but the pieces available are so small that they are not considered by timber-dealers in India.

5. *Quisqualis* Linn. *Q. indica* Linn. is a very common ornamental climber cultivated everywhere in India under the name

of Rangoon climber. The creeper is peculiar in that the petioles are articulate. The portion below the articulation becomes woody, and eventually acts as a hook which enables the plant to attach itself to a support. The flowers are almost all calyx, which is 2-3 in. long, with five small petals at the top. The flowers are white at first, then turn red or orange, often parti-coloured in the intermediate stages.

6. *Combretum* Linn. This is a large genus of trees or shrubs, generally climbing. There are a good many species in India and it is not necessary to give details of them all. They can all be distinguished from other genera in the family by their 4-6-winged fruits which are 1-seeded, and by the possession of petals. There is one exception to the latter, *C. apetatum* Wall., a deciduous scandent shrub found in Burma. It is, however, not likely to be mistaken for a *Terminalia*. One striking species is also one of the commonest. This is *C. decandrum* Roxb., a large scandent shrub, which is common over the greater part of India. When about to flower the floral bracts become large and conspicuous, and turn creamy-white. As this creeper is exceedingly common in deciduous forest it changes the whole aspect of the forest. Several species are said to be of use as vermifuges, and others are used in indigenous medicine.

73. RHIZOPHORACEAE

Trees or shrubs, usually littoral, occasionally inland (*Carallia*); branches swollen at the nodes. Leaves opposite (in all Indian species), simple, coriaceous, stipulate; stipules interpetiolar, caducous. Inflorescence usually of single flowers or of few-flowered cymose clusters from the leaf-axils. Flowers hermaphrodite, actinomorphic. Calyx-tube adnate to the ovary, 3-14-lobed; lobes valvate. Petals as many as the sepals, usually small, concave or convolute, notched, bifid or lacerate, rarely entire, convolute or inflexed in the bud. Stamens 2-3-4, being as many as the petals or numerous, often in pairs opposite the petals, situated on the outer edge of a lobed or perigynous disk; the anthers are 4-locular, except in *Rhizophora*, in which there are many pollen-sacs, dehiscing introrsely by longitudinal slits. Ovary mostly inferior, 2-6-locular, or occasionally incompletely 1-locular by the suppression of the septa; ovules two in each loculus, pendulous from the inner angle of the loculi; style single; stigma small, lobed. Fruit leathery, indehiscent, usually 1-seeded. Endosperm fleshy or absent.

The species of this family are sometimes confused with the *Garcinias* and *Eugenias* by reason of their opposite leathery leaves. It will be remembered that *Garcinia* possesses a latex in the bark and that the leaves of *Eugenia* are gland-dotted. Students will do well to remember that only two families, *Rubiaceae* and *Rhizophoraceae*, have interpetiolar stipules.

All the Indian genera except one (*Carallia*) are to be found on the seashore where they flourish in the mud of tidal swamps. Most of the species possess remarkable adaptations which enable them to exist in such habitats. In *Rhizophora* and other genera the fruits germinate while still upon the tree and make considerable growth before they fall vertically and drive the radicle into the mud. In most species the leaves are fleshy and coriaceous with a very thick cuticle and much water-storing tissue. The species develop horizontal roots in order to anchor themselves securely in the tidal mud. From these horizontal submerged roots arise knees (pneumatophores) or lateral branches which emerge above the mud.¹ *Rhizophora* develops a normal trunk in early youth but the lower part soon rots away and the tree is left supported upon stilt-like roots. Other genera keep a normal trunk throughout their lives and most develop strong buttresses at the base.

Key to the genera of *Rhizophoraceae*

Littoral; fruits germinating on the tree:

Leaves more or less elliptic, acute or tapering at both ends:
Petals 8-14, bifid or emarginate; ovary 2-4-locular,
inferior ... 1. *Bruguiera*

Petals 4, entire; ovary 2-locular, half-inferior

2. *Rhizophora*

Leaves more or less oblong or obovate, tip obtuse or emarginate; sepals and petals 5-6:

Shrub; leaves 3-5 in. long, stamens many 3. *Kandelia*

Small tree; leaves 2-4 in. long; stamens 10-12

4. *Ceriops*

Inland tree

... 5. *Carallia*

In short, the following are the field characteristics of the four littoral species (after Watson).

Bruguiera: Stem more or less buttressed, rarely with aerial roots; leaves tapering to both ends, not mucronate; calyx 7-14-cleft; pneumatophores numerous, sharply kneeed, with normal bark.

Rhizophora: Stem supported at the base by numerous stilt roots; leaves tapering to both ends, mucronate, more or less black-dotted on the lower surface; calyx 4-cleft; no pneumatophores.

Kandelia: Stem conically thickened at the base but not truly buttressed; leaves oblong, obtuse, with narrowed base; flowers conspicuous; calyx 4-6-partite; pneumatophores absent.

Ceriops: Stem buttressed; leaves obtuse or emarginate with narrowed base; flowers small; calyx 5-6-partite; pneumatophores kneeed, with scaly bark.

¹ See references under *Bruguiera* and *Sonneratia*.

1. *Bruguiera* Lam. A small genus of mangrove trees found in the tidal forest and swamps of India, Burma and the Andamans. The main roots of most species of this genus grow horizontally outwards. Here and there they rise above the surface of the mud, form an arch, and then grow forward again under the muddy soil. In connexion with these knees, as they are called, secondary tissue, with abundant intercellular spaces, is formed, a circumstance which has given rise to the belief that the knees are in some way connected with respiration. It has been found that absorbing roots are developed from these knees, and that the old knees which become submerged are discarded. It may well be that their more important function is the provision of absorption roots close to the surface of the soil as in the case of *Sonneratia*.¹

Key to the four species found in this area

Flowers solitary, axillary, large; calyx red:

Petals 2-lobed; lobes with 2-4 bristles, glabrous

B. conjugata

Petals 2-lobed; lobes with 1 bristle in the cleft; inner face woolly

... *B. sexangula*

Flowers cymose, small, green:

Calyx-lobes as long as the tube; petals bifid

B. cylindrica

Calyx-lobes quarter length of tube; petals emarginate

B. parviflora

B. conjugata Merr. (*B. gymnorrhiza* Lam.) is a tree which, according to Burkill, attains a height of 120 ft., but Troup and Brandis say that it only reaches 80 ft. in favourable circumstances. It is the largest of the mangroves and has a dark rough deeply fissured bark with large corky lenticular patches. The flowers are large, solitary, orange or red. Unlike the species of *Rhizophora* it is not supported on stilt-like roots. The bark is said to be moderately good for tanning. It is said to form patches of pure forest at the tops of large creeks in the Andamans. According to Watson² this tree marks the last stage of the mangrove forest, where ordinary land forest is intruding.

B. sexangula Pers. (*B. eriopetala* Wight) is very similar to the former but is rather smaller and with large solitary yellow flowers. It occupies parts of the mangrove forests which are frequently submerged. It is the only *Bruguiera* which stands on stilt roots, and that only occasionally, but the number of petals at once separates it from *Rhizophora*, with which its habit is likely to confuse it. The bark is used for tanning.

¹ See references under *Sonneratia*.

² *Malayan Forest Records*, vol. 6, 1928, p. 133.

B. cylindrica Blume (*B. caryophylloides* Blume). This tree reaches a height of 70 ft. in favourable areas but is usually much smaller in India. It occupies the highest parts of the mangrove forest where submergence is occasional and it often forms extensive pure stands. Watson (loc. cit.) looks upon it as a precursor of the *Rhizophoras* in most situations where accretion of soil is taking place on the sea-face, and as likely to be displaced by them. The flowers are small and white and the foliage light-green.

B. parviflora W. et A. is a tree which may attain a height of 70 ft. but is usually much smaller, and, according to Parkinson, does not exceed 30 ft. in the Andamans. The bark is rough and dark and the foliage light-green, somewhat lighter than that of the last-named. It usually occurs mixed with *Rhizophora candelaria*. Watson (loc. cit.) calls it a short-lived species and says it is more tolerant of submergence than *B. cylindrica*. It usually appears on soil from which the valuable mangrove species have been removed and when established acts as a nurse for the *Rhizophora* seedlings. The bark is said to be of little use for tanning.

Another species of *Bruguiera* has been described from Burma under the name *B. hainesii* C. G. Rogers. According to the author of the species¹ the new species differs from both *B. conjugata* (*B. gymnorhiza*) and *B. sexangula* (*B. eriopetala*) in the size of the tree and in the bark. Both these latter species are the same size. They attain a height of 60-80 ft. with a clean bole of 40-60 ft., with a girth at breast-height over the bark of 40-54 in. The new species grows to a height of 100 ft., with a clean bole of 75 ft. and a much rougher somewhat tessellated bark and a girth of 60-72 in. It is a distinctly taller and larger tree. This tree is said to be common in the Mergui district of Burma. It is possibly not a good species.

2. *Rhizophora* Linn. A genus of few species of which two are found in India and Burma.

The two can be separated by the following key.

Leaves broad, elliptic; cymes 3-flowered; petals fleshy, woolly	...	<i>R. mucronata</i>
Leaves narrowly lanceolate; cymes 2-flowered; petals thin, glabrous	...	<i>R. candelaria</i>

R. mucronata Lam. is a mangrove which may reach 90 ft. in favourable conditions; actually it is usually much smaller than this. It occurs on the coast of the Indian Peninsula from Sind to Burma and in the Andamans. The stem in closed forest is cylindrical with a black or reddish, scaly bark, with fissures which encircle the stem horizontally. The fruit germinates on

¹ *Kew Bulletin*, 1919, p. 225.

the tree and the extruded radicle may reach a length of 2 ft. or more. According to Parkinson the tree forms impenetrable belts of vegetation on the seashore extending for many miles and often a mile thick. The wood of this species is greatly valued as fuel, having a high calorific value. It is also extremely easy to split. The bark is rich in tannin and also gives a dye which is used for dyeing and strengthening fishing nets.

R. candelaria DC. (*R. conjugata* Kurz non Linn.). A tree as large as the above named, and occurring mixed with it in the same habitats, but easily separated from it by the grey almost smooth bark with shallow vertical furrows or short horizontal fissures.

3. *Kandelia* W. et A. The only species of this genus, *K. rheedii* W. et A., occurs in the tidal flats of the west and east coasts of the Peninsula and also in Burma and is a small tree up to 20 ft. in height. The bark is smooth, lenticellate, reddish-brown on the stem, pale and flakey at the base. The flowers are handsome, white, produced in axillary pendunculate, dichotomously branched cymes. The bark contains tannin.

4. *Ceriops* Arn. There are two species of this genus in the tidal forests of India and Burma.

They may be separated by the following key.

Petals tipped with 3-4 capitate bristles	...	<i>C. tagal</i>
Petals tipped with many cilia	...	<i>C. roxburghiana</i>

C. tagal C. B. Robbins (*C. candolleana* Arn.) is a small evergreen tree with many basal buttresses, which is said to attain a height of 80 ft. in the Malay Peninsula, but hardly reaching 30 ft. in this country and often degenerating into a bush. It is gregarious and small patches growing thickly together are common. The bark is fawn-coloured, smooth, occasionally flaked or slightly scabrous on old trees, conspicuously lenticellate. The timber is hard and is used for knees for boats. The bark is used for tanning.

C. roxburghiana Arn. is a small evergreen tree similar to the preceding. The leaves are obovate.

5. *Carallia* Roxb. There is one species in India, *C. brachiata* Merr. (*C. integerrima* DC., *C. lucida* auct.), a moderate-sized to large handsome evergreen tree, very common in the wetter parts of India. The bark is somewhat thick, with an outer dead corky layer, furrowed, dark-grey in colour, pink when cut, the inner living cortex pale greenish-yellow or pinkish when newly cut, turning orange-brown on exposure (Troup). Large tufts of aerial roots are often to be found on stem and branches. The timber is very handsome if cut radially, and should be prized for furniture, but supplies are nowhere abundant. The tree is often mistaken for a *Garcinia*, but this should not occur if it is

recollected that the bark of the latter exudes a white or yellow juice when blazed.

74. SONNERATIACEAE

Trees. Leaves opposite, simple, very coriaceous, entire, exstipulate. Inflorescence axillary or terminal, of single, or a group of three flowers. Flowers actinomorphic, often large and showy. Calyx-tube campanulate, thick and leathery, 4-8-lobed; lobes valvate. Petals 4-8, absent or caducous. Stamens numerous, inserted on the calyx in several series; filaments free, at length reflexed; anthers 2-locular, reniform, versatile, opening lengthwise. Ovary adnate to the calyx-tube at the base or free, 4 - many-locular; ovules on axile placentas; style long, simple. Fruit a capsule, dehiscing loculicidally, indehiscent or a berry. Seeds without endosperm.

There are two Indian genera, one of which, *Sonneratia* Linn. f., is littoral and the other, *Duabanga* Ham., inland.

Sonneratia Linn. f. The species of this genus are found in the mangrove forests of the Andamans and the coasts of Burma. The flowers, which open in the evening, smell of sour milk. Four species are found in these forests.

Key (after Parker)

Flower-buds pointed:

Flowers solitary; leaves elliptic or elliptic-oblong, tipped with a small recurved mucro; nerves distinct; petals conspicuous ... *S. caseolaris*

Flowers usually in clusters of 2-3; leaves obovate, obtuse; nerves obscure; petals absent ... *S. alba*

Flower-buds obtuse:

Leaves obovate or almost orbicular; sepals 6-8

S. griffithii

Leaves several times as long as broad; sepals 4

S. apetala

S. caseolaris (Linn. f.) Engl. (*S. acida* Linn. f.). This species is a tree up to 50 ft. high with pendulous yellow twigs which give the tree an appearance of being a willow. Found on the west coast of Bombay State, in the Andamans and in Burma. The bark is smooth, grey, lenticellate when young, light-brown and irregularly fissured when old; blaze dark-brown, watery, laminated. Pneumatophores are produced by this tree in the tidal swamps where it is usually associated with *Avicennia officinalis* Linn.

S. alba Sm. A moderate-sized tree found in the Andamans and in the tidal swamps of Burma. The bark is similar to that of *S. caseolaris* but the blaze is yellowish and fibrous.

S. griffithii Kurz. An evergreen tree which attains a height of 40 ft. in Mergui, Burma, but in Malaysia it is stated to be the

tallest tree in the mangrove swamps. The bark is brown and fissured and the blaze is pinkish, not, or only slightly, laminated.

S. apetala Ham. A small to moderate-sized evergreen tree with slender drooping branches. The bark is black, smooth, with horizontal oval lenticels. This tree is found in the tidal forests of Bengal, Bombay State and Burma. The wood is said to be an excellent fuel and is known as Keora in the trade.

The primary function of the aerial root-branches of *Sonneratia* was considered for a long time to be the promotion of an exchange of gases between the buried roots and the external atmosphere. It was believed that the buried roots were inadequately supplied with oxygen and therefore the aerial parts must be connected with respiration. This explanation is the more plausible when it is realized that the oxygen content of tidal mud-flats is almost nil and that the aerial parts contain numerous intercellular spaces originating in the cortex. Plausible though this theory may be, recent research has shown that this interpretation is by no means the whole story.

Troll points out that the level of the mud in the tidal creeks in which mangroves flourish is continually rising, a fact which he attributes to the deposit of colloidal matter carried down in the fresh water of rivers as a result of the contact of the latter with salt water. Therefore as time goes on the roots of *Sonneratia* and other mangroves become more and more deeply buried and therefore in a position in which the absorption of food must be relatively difficult.

A study of root development in *Sonneratia* revealed that the seedling is provided at first with a single root with numerous branched side-roots. Later, when the level of the mud has risen, a further set of adventitious side-roots is developed on the main stem just below the mud level, and when this happens the older root becomes disused and rots. The roots which run out horizontally below the surface of the mud send up aerial portions which arise as typical branches in the pericycle of the horizontal roots, above the water and mud. It is this portion which is said to be concerned with the exchange of gases. It is found, however, that connected with these aerial parts, there are developed absorbing roots just below the level of the mud, where conditions are considered to be best for the absorption of food.

Troll¹ is convinced that the most important function of the aerial parts is to ensure a constant supply of absorbing roots just

¹ W. Troll, *Ueber die sogenannten Atemwurzeln der Mangroven*, *Berichte der Deutschen Botanischen Gesellschaft*, Gen. Heft, pp. 81-99: also see C. R. Metcalfe, *The Breathing Roots of Sonneratia and Brugiera* (a review of Troll's work), *Kew Bulletin*, 1931, p. 465.

below soil level. At the same time he observes that the possibility of their acting as organs for gas exchange is not thereby excluded. He actually found that a considerable quantity of carbon dioxide was given off, but he refrained from coming to any conclusion until a complete study of the metabolism of the tree is carried out.

Duabanga Ham. The only species in this genus, *D. grandiflora* (Roxb.) Walp., is found in the eastern sub-Himalayan tract in Assam, and in Chittagong, Burma and the Andamans. It is a very tall deciduous tree, with a greyish-brown bark peeling off in flakes; blaze dry, dirty-brown, darkening immediately near the sap-wood. It is a very easy tree to spot in the jungle. The branches are long, horizontal, drooping at the tip and the leaves are large and opposite. The flowers, which are large and pure white, open at night and emit a strong smell of sour milk. These flowers are collected into heads at the tips of the drooping branches. Commonly found on the banks of streams in warm moist climates. The wood is said to be excellent for tea-boxes and also for match manufacture. It is known as Lampati in the trade.

75. PUNICACEAE

Small trees or shrubs, sometimes spiny. Leaves usually crowded on lateral short branches, membranous, simple, exstipulate. Inflorescence of solitary flowers or fascicles of 2-3. Flowers hermaphrodite, large, coloured. Calyx coloured, adnate to the ovary, turbinate, 5-7-lobed; lobes valvate. Petals as many as the calyx-lobes, imbricate and crumpled in the bud, inserted at the top of the calyx-tube. Stamens numerous, many-seriate at the top of the calyx-tube; anthers 2-locular, dorsifixed, opening by longitudinal slits; filaments filiform. Ovary inferior, many-locular, the loculi superposed in two rows with many ovules; ovules in the upper loculi attached to thick parietal placentas, in the lower to thick axile placentas; style filiform, flexuose; stigma capitate. This is possibly the only family in which the ovules are both axile and parietal. Fruit a spherical berry crowned by the remains of the calyx-limb, with a thick coriaceous rind, many-locular, with the loculi irregularly superposed. Seeds numerous, angular, covered with a sappy pulp, without endosperm.

Punica granatum Linn., the Pomegranate, the only species of this family in India, is supposed to have been introduced from Persia. It has been cultivated from very early times as a fruit-tree and is found all over India wherever human habitations are to be found. The bright-scarlet flowers yield a light-red dye. The roots are reputed to be of use in medicine as a vermifuge. The ovary is unique of its kind, in that the ovules are arranged on parietal placentas in the upper part and on axile placentas in the lower portion.

38. CELASTRALES

Trees, shrubs or climbers; flowers hermaphrodite, actinomorphic, usually small; sepals and petals present; ovary superior or sunk in the disk; stamens definite, alternate with petals; embryo straight; endosperm present.

76. AQUIFOLIACEAE 77. CELASTRACEAE
78. ICACINACEAE 79. SALVADORACEAE

76. AQUIFOLIACEAE (ILICACEAE)

As far as India is concerned this family contains only one genus, *Ilex* Linn., the Holly, and the family characters are reduced to apply to this genus only.

The genus contains trees or shrubs with white, close-grained wood. The leaves are alternate, simple, coriaceous, evergreen (with a few exceptions which will be enumerated below), stipules absent. The inflorescence is of sessile or pedunculate paniced or umbellate cymes or of fascicled clusters. Flowers dioecious, sometimes hermaphrodite. Calyx 4-5-lobed, with persistent lobes; lobes hypogynous, small. Petals inconspicuous, the same number as the sepals and alternate with them, connate at the base, deciduous, imbricate. Disk absent. Stamens as many as the petals and alternate with them; anthers opening by slits. Ovary 3- or more-locular; style terminal, very short or more usually absent; stigmas free or confluent, as many as the loculi; ovule one in each loculus, pendulous from the top. Fruit a drupe containing one to several 1-seeded pyrenes, supported by the persistent calyx; embryo small and straight, sunk in a copious fleshy albumen. A large proportion of the species of *Ilex* conforms to the formula $S_4, P_4, A_4, G(4)$.

There is one species, common in Bengal and Assam, which is deciduous. This is *Ilex godajam* Colebr. It is easily recognized in the forest by its bark, which is very thick, soft and horizontally wrinkled. Moreover the blaze is white with a red or purple ring next the milk-white sap-wood. *I. insignis* Hook. f. is a common species of the upper hill-forests in Sikkim; it has toothed leaves 6-9 in. long and scarlet berries. The genus as a whole is confined to the wetter parts of India and hence is strongly represented in the eastern Himalayas and in Burma. *I. dipyrena* Wall. is a small tree of the western Himalayas with a rough dark-grey bark and a red fruit containing two grooved stones. *I. doniana* DC. (*I. excelsa* Wall.) is another tree of the western Himalayas, readily recognized by its soft silvery-white bark with a yellowish blaze. This particular species grows to a fair size in Tehri-Garhwal between 4,000 and 6,000 ft.

77. CELASTRACEAE

Trees, shrubs or climbers. Leaves alternate or opposite, simple, entire or toothed, often coriaceous; stipules small and caducous or absent altogether. Inflorescence generally axillary, cymose or fasciculate. Flowers actinomorphic, hermaphrodite, occasionally unisexual, often small. Calyx 4-5-lobed; lobes persistent, imbricate, equal. Disk present, fleshy, flat, lining the short calyx-tube, often enclosing the ovary. Petals 4-5, alternate with the sepals, inserted under the edge of the disk by a broad base, sessile, imbricate, deciduous. Stamens 4-5, alternate with the petals, inserted on or below the margin of the disk; filaments short; anthers 2-locular, opening by longitudinal slits. Ovary superior, more or less sunk in the disk and occasionally adherent to it, 1-5-locular; style short, thick, more or less 3-lobed; ovules generally two, with axile placentation. Fruit often a capsule with loculicidal dehiscence, occasionally a drupe or aggregate; embryo straight, large; endosperm copious; cotyledons foliaceous, flat.

This family is well represented in India with about thirteen genera, but only a few species are important forest trees. By far the largest number of species are either shrubs or climbers. The flowers of many species are very characteristic by reason of the conspicuous flat disk with the spreading petals (not clawed) attached to its margin.

The following is a key to the more important genera of this family.

- Fruit not woody:
 - Leaves opposite:
 - Fruit a dehiscent capsule:
 - Tall trees:
 - Seeds arillate ... 1. *Lophopetalum*
 - Seeds exarillate ... 2. *Kokoona*
 - Small trees or shrubs:
 - Petals free:
 - Petals foveolate ... 3. *Glyptopetalum*
 - Petals efoveolate ... 4. *Euonymus*
 - Fruit indehiscent:
 - Shrubs ... 5. *Pleurostyliia*
 - Trees ... 6. *Elaeodendron*
 - Leaves alternate:
 - Trees ... 7. *Kurrimia*
 - Shrubs, climbers or small trees:
 - Scandent shrubs ... 8. *Celastrus*
 - Small trees ... 9. *Gymnosporia*
- Fruit woody, pyriform ... 10. *Siphonodon*

1. *Lophopetalum* Wight. A genus of large trees of which about six species are found in Assam and Burma. The capsule is a

large, leathery 3- or 4-angled structure, containing numerous seeds winged all round. Three species are common.

The following is a key to these species.

Flowers 0.75 in. in diameter, dull-red	...	<i>L. wightianum</i>
Flowers 0.3-0.5 in. in diameter:		
Petals fimbriate	...	<i>L. fimbriatum</i>
Petals entire	...	<i>L. wallichii</i>

L. wightianum Arn. is a common tree in the forests of the Western Ghats. It grows to a very large size. The bark is rough greyish-brown in colour, soft and brittle. The blaze is flesh-coloured with a yellow line under the cuticle. When the outer surface of the bark is rubbed off a yellow powder is obtained. Of the other two species, *L. fimbriatum* Wight is an inhabitant of the lower hill-forests of Bengal and the plains of Assam. It is also found with *L. wallichii* Kurz in Burma. The timber of the species of this genus is not of much account as it is not durable out of doors. It is, however, used for planking, doors and window-frames, cheap furniture, etc. According to Bourdillon it lasts longer if smoked.

2. *Kokoona* Thw. This was, until recently, a genus with two species, one being *K. littoralis* Lawson (*Lophopetalum littorale* Kurz), the other *K. zeylanica* Thw. from Ceylon. The former species is a large evergreen tree, indigenous in Burma, which grows on low land, inundated during the rains, or in flooded land. The 3-angled capsules are similar to those of *Lophopetalum* but the seeds are winged at the apex, the wing being up to 2 in. long. Another species, *K. filiformis* C.E.C. Fischer, has recently been described from south Tenasserim. It is a small tree 30-40 ft. tall with an ash-grey bark exfoliating in white patches. The blaze is pinkish-red. The wood does not seem to have any value. In contrast to the other species *K. filiformis* is always found on low hills.

3. *Glyptopetalum* Thw. This is a genus of a number of small trees chiefly found in the evergreen forests of Madras State but with representatives in the evergreen forests of the Andamans and Burma. The genus is easily recognized in flower from the two pits at the base or apex of the petals.

4. *Euonymus* Linn. This genus has species all over India and Burma, mostly in evergreen climax formations in hills and plains. The flowers are of the typically Celastraceae type, but the 3-5-locular loculicidal capsule which is lobed, angled or winged is quite characteristic. The seeds are often covered with a red arillus. Of no account in forestry, the species are important members of the undergrowth in climax forest.

5. *Pleurostyliia* Wight. There is one species of this genus, *P. wightii* W. et A., in India, and it is confined to the Peninsula. It is a graceful little tree somewhat resembling the sandal tree.

The bark is grey outside and yellow inside. The wood is very beautiful and is in much demand for furniture while combs are made from it in Cuddapah.

6. *Elaeodendron* Jacq. f. These are deciduous or evergreen trees with a smooth grey to blackish bark and opposite crenate leathery leaves. There are two species in India proper.

Leaves ovate or elliptic, pale-grey when dry *E. glaucum*

Leaves lanceolate or oblanceolate, almost black when dry

E. paniculatum

E. glaucum Pers. is found all over India. It possesses a bark which is whitish-grey or dark, exfoliating in small dark 4-sided scales. *E. paniculatum* W. et A. is found in the forests of the Western Ghats. Another species, *E. subrotundum* King, with leaves which are almost rotund, is found in the Andamans.

7. *Kurrimia* Wall. Two species of this genus are found in India. One, *K. robusta* Kurz (*K. pulcherrima* Wall.), is found in northern and eastern India, the other, *K. indica* Gamble (*K. bipartita* Law.), in the Deccan Peninsula. The former is a middle-sized tree with coriaceous glabrous leaves. The capsule is about 1.5 in. long, beaked, with two vertical grooves, and splits up one side. The seed is covered with a yellow aril. The latter tree has a 2-lobed capsule 1.5 in. long, containing a seed enveloped in a white aril. The timber is only of local use.

8. *Celastrus* Linn. A genus of scandent shrubs of which there are many in India, which are easily recognized in the forest from the loculicidal capsules containing 1-6 seeds, each covered with a red arillus.

9. *Gymnosporia* Wight et Arn. This genus consists of small thorny shrubs or trees. The stout thorns often bear leaves and flowers and the globose capsules contain aril-covered seeds.

10. *Siphonodon* Griff. This is a monotypic genus. The one species, *S. celastrinus* Griff., is found in Bengal, Assam and Burma. It is a middle-sized evergreen tree. The bark is dark-grey in colour, brittle, granular and rough from the transverse stout corky lenticels. The fruit is a woody berry 1-2 in. long, containing numerous transversely superposed woody pyrenes embedded in a granular pulp.

78. ICACINACEAE

Trees or shrubs. Leaves usually alternate, simple, exstipulate. Inflorescence of terminal corymbose panicles or terminal leaf-opposed cymes, or in globose heads or in globose clusters or racemose panicles. Flowers actinomorphic, hermaphrodite or unisexual, dioecious. Calyx small, inferior, 4-5-lobed; lobes imbricate or rarely valvate. Petals 4-5, free or united, valvate, rarely

absent. Stamens free, the same number as the petals and alternate with them; anthers 2-locular, opening by longitudinal slits; filaments often hairy below the anthers. Disk rarely present. Ovary superior, free, 1-locular with 1-2 ovules pendulous from the top of the loculus, very rarely with three perfect 1-2-ovuled loculi; style usually short. Fruit a drupe, 1-locular, 1-seeded. Seeds usually with endosperm. Embryo usually small, straight.

A family which is of little importance to the forest officer. Some of the genera, however, enter largely into the composition of the undergrowth of our evergreen forests. The species are easily recognized when the inflorescence is in bud from the shape of the latter. The buds are very tiny and globose, the calyx being lighter in colour than the closed petals. The latter are black when dry. The fruit is crowned with the remains of the stigma.

Gomphandra polymorpha Wight is very common in the undergrowth of the forests of certain parts of the Western Ghats, e.g. in Silent Valley, Malabar District. It is a small tree with membranous, lanceolate leaves, with the lateral nerves joining in loops. The fruit is longitudinally furrowed. *G. axillaris* Wall. is a very similar small tree common in the forests of North Kanara in Bombay State.

Apodytes C. A. Mey. The members of this genus are small trees. When dry the leaves turn black. One species, *A. beddomei* Mast., is met with in Madras and Bombay States. The bark is about 0.5 in. thick, dark, rough, scaly with short gaping fissures in the corky layer, reddish-white beneath.

A striking climber is *Sarcostigma kleinii* Wight et Arn. The ellipsoidal fruit, bright orange-yellow in colour, 1.5 in. long, seated on the axis of the inflorescence, is most conspicuous. The leaves are very coriaceous and prominently reticulate.

79. SALVADORACEAE

Glabrous shrubs or trees. Leaves opposite, petioled, entire, coriaceous, obscurely veined, stipulate; stipules minute. Inflorescence of axillary fascicles, or axillary or terminal panicles. Flowers actinomorphic, tetramerous, hermaphrodite or dioecious (*Azima*). Calyx-tube 4-toothed or 4-lobed. Corolla of four, free or connate, imbricate petals, hypogynous. Stamens four, inserted on or near the base of the petals and alternate with them; filaments free or connate at the base; anthers 2-locular; loculi back to back, opening by longitudinal slits. Disk present, hypogynous, 4-lobed. Ovary superior, free, 1-2-locular; ovules 1-2 erect; style short; stigma 2-lobed. Fruit a berry or drupe. Seed without endosperm; embryo with thick cordate cotyledons.

This small family is represented in India by two genera,

Salvadora and *Azima*, both of which are confined to the drier parts of India.

Unarmed trees	...	1. <i>Salvadora</i>
Armed rambling shrubs	...	2. <i>Azima</i>

1. There are two species of *Salvadora* which may be separated by the following key (Parker).

Flowers pedicelled; leaves at least 0.7 in. broad; ripe fruit red
S. persica

Flowers sessile; leaves less than 0.7 in. broad; ripe fruit yellow
... *S. oleoides*

S. persica Linn. is known as the Toothbrush tree and the Mustard tree (of Scripture). It is a small evergreen tree, with drooping branches and a pale almost white bark, which is an inhabitant of the dry and arid regions of India. It can grow both on saline and on black cotton soils. It is also found in the coastal districts just above high-water mark. The twigs are often used as toothpicks. It is a valuable shady tree in dry districts.

S. oleoides Dcne. is a large shrub or small tree with rather stiff drooping branches and a rough grey bark. The species is found in the arid desert tracts of the Punjab and, therefore, is useful for afforesting dry places. It is very abundant in the so-called *rakhs* of the Punjab, where it is associated with *Prosopis spicigera* and *Capparis aphylla*. The wood is not often used, and, being a bad fuel-wood, is not usually cut by the inhabitants of these areas when they make new clearings for cultivation.

2. *Azima* Lam. There are two species of this genus in India. One, *A. tetraacantha* Lam., is a rigid spinous shrub found in the drier parts of the Deccan Peninsula where it makes an excellent hedge. *A. sarmentosa* Benth. is a rambling shrub found in the drier parts of the Irrawaddy Valley. The fruits and leaves are medicinal.

39. MYRSINALES

Trees or shrubs; flowers hermaphrodite, rarely dioecious, small; petals united; ovary superior to half-inferior; stamens epipetalous, same number as petals and opposite to them; embryo large, straight or curved; endosperm present.

80. MYRSINACEAE 81. SAPOTACEAE

80. MYRSINACEAE

Trees or shrubs. Leaves alternate, simple, coriaceous, with translucent glandular dots or lines, exstipulate. Inflorescence of

dense axillary clusters, or simple or compound racemes or panicles. Flowers actinomorphic, hermaphrodite, sometimes showy. Calyx of free or connate sepals; sepals 4-5, often punctate, valvate, imbricate or contorted, persistent. Corolla gamopetalous, rotate or tubular, 4-5-lobed; lobes often gland-dotted, valvate, imbricate or contorted. Stamens the same number as the petals and opposite to them; filaments adnate to the corolla-tube; anthers 2-locular, opening by longitudinal slits or by apical pores. Ovary superior or half-inferior, 1-locular; style short, simple; stigma undivided; ovules numerous on a free central placenta. Fruit a berry or drupe. Seeds with endosperm; embryo straight or curved.

A large family of shrubs, climbers and small trees which is well represented in India. It is of little importance to the forester although many species are found in the forests. It resembles *Primulaceae* in the possession of a free central placenta but differs in the woody habit and few-seeded fruit. A characteristic of the leaves of this family is the presence of schizogenous lines and dots in the leaves which enables it to be spotted in the field when flowers and fruit are absent. The leaves of some species of *Ardisia* are moreover distinguished by the presence of the so-called protein-glands. These glands secrete a substance which is of the nature of protein. The only species of this family which can be deemed to be of any importance is a mangrove, *Aegiceras corniculatum* Blanco (*A. majus* Gaertn.). This species is a shrub or occasionally a small tree found on the sea-coasts of India and Burma and also in the Andamans. In the Andamans it is known as the Black Mangrove. The flowers are white and scented and the fruits, 1-2 in. long, are curved like the horns of a ram. The bark contains a substance which can be used as a fish poison and the seeds also contain the same poison in a much more concentrated form.

81. SAPOTACEAE

Trees or shrubs with milky juice, often thorny, occasionally without milky juice (*Monothea*). Leaves alternate, sometimes sub-opposite (*Sarcosperma*), entire, coriaceous, exstipulate. Inflorescence of flowers in axillary clusters. Flowers actinomorphic, hermaphrodite. Calyx 4-8-lobed. Corolla gamopetalous, 4-8-lobed; lobes sometimes in two series, imbricate. Stamens inserted on the corolla, dimorphous, the fertile equal in number to the corolla-lobes and opposite to them or more numerous and 2- or more-seriate; staminodes sometimes present; anthers opening by longitudinal slits. Ovary superior, several-locular; ovules solitary in each loculus, ascending from the base of the inner angle, anatropous; style simple. Fruit a 1- many-locular berry. Seeds with a bony shining testa, with scanty or without endosperm; embryo large with foliaceous cotyledons.

A family of considerable importance to the forest officer and easily recognized by the alternate leaves and milky juice in the bark.

The following is a key to the genera.

Trees with milky juice:

Calyx-lobes 1-seriate; stamens 5-6:

Staminodes 0; leaf main-nerves close and parallel

1. *Chrysophyllum*

Staminodes present; leaf main-nerves distant, few:

Ovary 5-locular ... 2. *Sideroxylon*

Ovary 1-2-locular ... 3. *Sarcosperma*

Calyx-lobes 2-seriate, outer series valvate:

Calyx-lobes 4:

Stamens 8; seeds with endosperm 4. *Isonandra*

Stamens 12 or more; seeds without endosperm

5. *Madhuca*

Calyx-lobes 6-8:

Fruit as large as an orange ... 6. *Achras*

Fruit much smaller:

Staminodes absent ... 7. *Palaquium*

Staminodes present:

Flowers normally tetramerous 8. *Mimusops*

Flowers normally trimerous ... 9. *Manilkara*

Shrubs without milky juice ... 10. *Monothecca*

1. *Chrysophyllum* Linn. There is one species, *C. roxburghii* G. Don, found in the forests of the Western Ghats, in the Khasi Hills and in Burma. It is a middle-sized, sometimes a large, evergreen tree with a smooth, dark-grey bark. Very easily recognized in the forest from its milky juice and coriaceous elliptic evergreen leaves, with close parallel nerves and, occasionally, rusty hairs below. The leaves are somewhat like those of *Calophyllum*, but as they are alternate the tree is not likely to be mistaken for that genus. The fruit, too, is very characteristic. It is a fleshy or coriaceous globose berry with a number of hard flat brown polished seeds. The wood is of no importance. Another species of the genus, *C. cainito* Linn., a native of Jamaica, is cultivated for its fruit and is known as the Star-apple. The flavour of the fruit is said to be excellent. The tree itself, with its handsome copper-tinged foliage, makes an excellent avenue tree.

2. *Sideroxylon* Linn. is a large genus of which most Indian species have been transferred to *Pouteria* Aubl. by C. Baehni of Geneva. It is a genus containing a number of small trees of which *Pouteria tomentosa* (Roxb.) Baehni (*S. tomentosum* Roxb.) is very common in the Western Ghats forests. It is a small thorny tree. The variety var. *elengioides* is found in the shola forests of the Nilgiris above 5,000 ft. It has rather longer

thorns than in the type and the small leaves are bright-red in colour when young.

3. *Sarcosperma* Hook. f. is a small genus with two species in India. One, *S. arboreum* Benth., is a large tree found in Bengal, Assam and Burma with sub-opposite leaves gland-pitted in the nerve-axils. The bark is greenish-grey and soft; blaze red with drops of milky juice. The other species, *S. griffithii* Benth., is similar, but thorny, and without pits in the axils of the leaf-nerves, and is found in Assam only.

4. *Isonandra* Wight. A genus with six species in south India of which five appear under the name *I. lanceolata* Wight in D. Brandis, *Indian Trees*.¹ J. S. Gamble in the *Flora of Madras*² has restored these trees to specific rank and gives a key. The species are small evergreen trees of no special importance.

5. *Madhuca* Gmelin (*Bassia* Koenig non Allioni). In this genus, which is perhaps more widely known by the invalid name *Bassia*, are to be found several species in India.

Key to the species

Stamens 30 or over; corolla not fleshy ... *M. butyracea*

Stamens up to 30: corolla fleshy or not:

Stamens over 20:

Anthers long-hairy on the back, obtuse at the base; petiole long; corolla fleshy ... *M. latifolia*

Anthers not long-hairy on the back, cordate at the base; petiole short, fulvous; corolla not fleshy

M. bourdillonii

Stamens less than 20:

Ovary and young fruit densely hirsute; corolla fleshy

M. longifolia

Ovary and young fruit glabrous; corolla not fleshy

M. malabarica

M. butyracea (Roxb.) Macbr. (*Bassia butyracea* Roxb.) is a large deciduous tree with very obovate leaves crowded at the ends of the branches. The bark is thick and dark-grey with a few drops of latex in the blaze. It is found in the sub-Himalayan tract from the Dun eastwards and ascends in the hills to 5,000 ft. The tree is valued for its fruit, the seeds of which yield a white vegetable butter. This butter can be made into soap, or used instead of tallow for candles. The oil-cake and the pulp of the fruit are eaten. The flowers contain quantities of nectar and this is pressed out and boiled. The gur so obtained is greatly valued in Kumaon.

¹ Constable & Co., 1906.

² Published under the Authority of the Secretary of State in Council, Calcutta, 1915.

M. latifolia (Roxb.) Macbr. (*Bassia latifolia* Roxb.). A large and handsome deciduous tree, one of the most important, in some respects the most important, of Indian trees. The bark is greyish-brown and nearly smooth, with vertical cracks; blaze thin, brown, red or dark-red, with visible latex tubes which exude a few drops of milky juice. This tree is very common in central India and is much planted in northern India. It owes its importance to the fact that the corollas of the flowers are very fleshy and sweet and form a valuable source of food. The corollas are eaten raw or cooked, or may be dried and, after being ground, made into cakes. A spirit can also be distilled from the flowers. According to Gamble the spirit is a powerful stimulant as well as an astringent tonic and appetiser. In Bombay State the fermented flowers are the main source of ethyl alcohol. The oil from the seeds is used to adulterate ghee, for cooking, for lighting and for the manufacture of soap and candles. The corollas have an irresistible attraction for bears. The unripe fruit is cooked and eaten as a vegetable. The timber is good, but trees are not cut for obvious reasons. This tree is planted all over India but it is indigenous in the Gangetic plain between the Ravi and the Great Gandak in the Peninsula.

M. bourdillonii (Gamble) comb. nov. (*Bassia bourdillonii* Gamble) is a rare tree of Travancore with a greyish-brown bark with deep cracks in it. Bourdillon says that the wood is good but not used.

M. longifolia (Linn.) Macbr. (*Bassia longifolia* Linn.) is a large evergreen tree with a thick spreading crown and lanceolate leaves crowded at the ends of the branches. The bark is yellowish-grey to brown; blaze red with drops of milky juice. The tree is indigenous in the evergreen forests of the Western Ghats from the Konkan southwards. It is common in many parts of India and is also said to be indigenous in Burma. This tree is a favourite avenue tree both in India and Burma because of its symmetrical shape and thick crown of handsome foliage. The flowers and fruits are used in the same way as those of *M. latifolia*. The heavy hard red-coloured wood is used by boat-builders in south India for keels and planking.

M. malabarica (Bedd.) R. N. Parker (*Bassia malabarica* Bedd.) is a small to medium-sized tree with dark-coloured scaly bark; blaze pink with fine drops of milky juice. It is found in south India in the evergreen forests of Bombay and Madras States. The wood does not appear to be of any use.

6. *Achras* Linn. This is a monotypic genus often cultivated in India. The species, *A. zapota* Linn. (*A. sapota* Linn.), is a native of Mexico, Colombia and Venezuela but is now cultivated everywhere in the moister tropics of the world. The fruit is as large as an orange and has a very delicate flavour. The tree, however, also yields a latex and is very extensively tapped for

this product in its native home. American chewing-gum is nothing more than this product, flavoured and moulded.

7. *Palaquium* Blanco is an important genus of trees because certain species yield the gutta-percha of commerce. Unfortunately the Indian species yield the product in a very inferior form and they are not worth tapping.

Two or three species are found in India.

Leaves velvety beneath ... *P. polyanthum*

Leaves glabrous:

Leaves elliptic to elliptic-obovate, dark-green when fresh,
nearly black when dry ... *P. ellipticum*

Leaves lanceolate or oblanceolate, light-green when fresh,
grey when dry ... *P. bourdillonii*

P. polyanthum Benth. is a middle-sized tree found in the evergreen climax forests of the Surma Valley, Assam, and extending into Burma via the Chittagong hill-tracts.

P. ellipticum Engl. is a lofty tree which sometimes reaches a height of 100 ft. with a straight but fluted stem. The bark is dark-brown, mottled with white; blaze with copious milk. Frequent in the evergreen climax forests of the Western Ghats.

P. bourdillonii Brandis is confined to Travancore.

8. *Mimusops* Linn. *M. elengi* Linn. is a large evergreen tree with a dark-grey scaly bark, longitudinally fissured, with vertical lenticels; blaze pink with redder streaks, exuding a milky juice. The leaves have wavy margins. The tree is found in south India and in Burma and is extensively planted elsewhere in India. The flowers are fragrant and are held to be sacred by the Hindus, who make garlands out of them. The flowers yield a volatile oil which is used as a stimulant medicine and perfume. The wood is very hard with a dark-red heartwood, and is durable.

9. *Manilkara* Adans. This genus name is now applied to several species formerly known as species of *Mimusops*.

The following key applies to the Indian species.

Leaves obovate, densely silky-white beneath ... *M. kauki*

Leaves glabrous:

Flowers solitary ... *M. littoralis*

Flowers in fascicles:

Flowers small; corolla under 0.2 in. long *M. hexandra*

Flowers larger; corolla about 0.4 in. long
M. roxburghiana

M. kauki (Linn.) Dubard (*Mimusops kauki* Linn.) is a medium-sized tree sometimes cultivated for the sake of its fruit which, however, is somewhat insipid. The timber is said to be very durable. The bark of this tree is greyish-brown, deeply fissured and cracked.

M. littoralis (Kurz) Dubard (*Mimusops littoralis* Kurz) is a fine large tree with a rough black bark, furrowed in old trees; blaze dark-reddish with a few drops of white juice. It is common along the coasts of the Andamans and adjoining islands where it forms a protective belt against the force of the south-west monsoon.

The timber is known as Andaman Bullet wood; it is red, very hard and durable. It is not attacked by white ants but is not proof against the teredo.

M. hexandra (Roxb.) Dubard (*Mimusops hexandra* Roxb.) is a very large tree with a tall stout unbranched trunk. The bark is blackish-grey, deeply furrowed vertically; blaze crimson, exuding a few drops of milky juice. The wood is very hard, heavy and tough and takes a high polish. The fruits when ripe are sweet and tasty and are collected in large quantities for food. This tree is found in the Indian Peninsula but is planted elsewhere in India. It is only a shrub in dry places.

M. roxburghiana (Wight) R. N. Parker (*Mimusops roxburghiana* Wight) is a tree which is also confined to the Deccan and Carnatic. It is a fine large evergreen tree. The timber is said to be reddish-brown and strong.

10. *Monothea* A. DC.: *M. buxifolia* Dcne. (*Reptonia buxifolia* A. DC.) is a thorny evergreen shrub or small tree with dark-grey bark, tessellated by deep longitudinal and transverse fissures. It is found in north-west India on dry rocky hills where it is associated with *Olea cuspidata*, *Acacia modesta*, *Sageretia brandrethiana* etc. (Parker).

40. OLACALES

Trees, shrubs or climbers; flowers minute, usually hermaphrodite, actinomorphic; petals valvate; ovary superior or sunk in the disk; ovules pendulous; stamens equal in number to petals and opposite to them; embryo straight; endosperm copious.

82. OLACACEAE

Trees or shrubs, erect or climbing. Leaves alternate, simple, exstipulate. Inflorescence of short axillary racemes or cymose axillary fascicles. Flowers actinomorphic, hermaphrodite, usually small. Calyx cup-shaped, obscurely 5-6-toothed; aestivation open. Petals 5-6, free or variously connate, valvate in the bud, often hairy within. Disk various, free or adnate to the calyx or the ovary, sometimes absent. Stamens as many as, and opposite to, the petals or more numerous or fewer, sometimes adnate to the petals or free, occasionally monadelphous; staminodes occasionally present; anthers 2-locular, dehiscing longitudinally. Ovary superior, free or partially sunk in the disk,

1-locular, or imperfectly 2-3-locular by intruded septa; style simple with a 2-5-lobed stigma; ovules 1-5 from the apex of the central placenta of the 1-locular ovaries, or pendulous from the inner angle of the 2- or more-locular ovaries. Fruit usually drupaceous, sometimes enclosed by the enlarged calyx. Seeds with copious endosperm. Embryo straight, medium-sized or small.

This family is not of much importance to the forester in India; it does, however, contain certain accessory species which are common in our forests.

The following key will distinguish the common genera in India.

Stamens twice as many as the petals ... 1. *Ximения*

Stamens as many as the petals:

Staminodes present:

Staminodes slender, bifid, usually 6; stamens 3; straggling shrubs ... 2. *Olaх*

Staminodes short, thick, as many as the stamens; climbing cirrhose shrubs ... 3. *Erythrophalum*

Staminodes absent, trees:

Calyx adherent to the fruit; anthers oblong, incurved; filaments very short ... 4. *Strombosia*

Calyx not adherent to the fruit; anthers globose, very small; filament slender ... 5. *Anacolosa*

1. *Ximения* Linn. One species, *X. americana*, a glabrous straggling shrub with spiny branches, grows on the shores of the Peninsula and the Andamans. The leaves are light-green in colour but dry black. The flowers are white and fragrant. The edible fruit is bright orange-scarlet.

2. *Olaх* Linn. A small genus of trees or scandent shrubs, the fruit of the species of which is covered by the accrescent calyx.

3. *Erythrophalum* Blume. This is a genus of climbing shrubs with cirrhose tendrils from the axils of the leaves. The leaves themselves are ovate with three basal nerves. The fruit is an oblong or obovoid yellow or scarlet drupe surmounted by the remains of the calyx. The leathery epicarp splits irregularly releasing the seed. The seed is embedded in a bluish fleshy arillus. *E. scandens* Bl. is an inhabitant of the evergreen forests of eastern India. *E. populifolium* Masters is found in Madras State.

4. *Strombosia* Blume. *S. ceylanica* Gard. is found in the climax forests of the Western Ghats. The *S. leprosa* Talb. is hardly distinct. The greyish-green oblong leaves are quite distinctive, especially accompanied by the fruit which is a pyriform, purple or purple-black drupe. Bark dark-brown, exfoliating in irregular flakes leaving white blotches. Blaze showing alternating layers of pink and white.

5. *Anacolosa* Blume. One species of this genus, *A. densiflora* Bedd., a lofty tree, is common in the evergreen forests of southern India. The pale-yellow very fragrant flowers are borne in enormous quantities on the branches and make the tree a conspicuous object when in flower. The wood is brittle and of no particular use. The bark is smooth, mottled yellow-brown and white, over 0.5 in. thick.

41. SANTALES

Parasitic trees, shrubs or herbs; flowers actinomorphic, hermaphrodite or monoecious; petals present or absent; ovary inferior with axile placentation; stamens definite, opposite the calyx-lobes; embryo straight; endosperm copious.

83. LORANTHACEAE 84. SANTALACEAE

83. LORANTHACEAE

Parasitic shrubs. Leaves opposite or alternate, rather leathery, simple, entire, exstipulate, or reduced to scales, and their functions assumed by flattened green branches. Flowers actinomorphic, hermaphrodite or unisexual, often coloured, arranged in racemes, spikes or fascicles. Calyx adnate to the ovary, often prolonged above it as a toothed ring. Perianth petaloid, of free or united petals, 4-6 in number, valvate in the bud, often split down one side. Stamens the same number as the perianth-lobes; inserted on the tube opposite to the lobes; anthers usually 2-locular, opening by pores or by slits. Ovary inferior, 1-locular; ovary and placenta not differentiated, completely filling the ovary. Fruit baccate, rarely drupaceous, with a viscid inner layer, by means of which it becomes adherent to the future host.

A family of parasitic shrubs, the species of which often attack forest trees.

Arceuthobium M. Bieb. is a genus which has the distinction of possessing in *A. minutissimum* Hook. f., the smallest dicotyledonous plant. It appears as small green pustules on the bark of *Pinus wallichiana*. Each pustule bursts and exposes a tiny plant, not more than one-fifth of an inch in length. It does considerable damage in blue-pine forests and has been known to kill off large numbers of this fine tree. *A. oxycedri* M. Bieb. occurs on *Juniperus macropoda* in Lahul, and the forest of this species north-east of Kyelang is very badly attacked, almost every tree being infested. The fruits are berries in which the seeds are embedded in a viscid mucous. When the berry dehisces the seeds are shot out with explosive force. Since the fruits are explosive and expel the viscid seeds if the branch be

shaken, it is thought that birds may aid in the dissemination of seed by carrying it on the plumage.¹

The genus *Loranthus* Linn. is important for the forest officer, because certain species are capable of destroying plantations over wide areas. *Loranthus scurrula* Linn. (*Scurrula parasitica* Linn.) is fatal to pure plantations of *Gmelina arborea* Roxb., and is the most cogent argument against planting this species over large areas without a high admixture of other species.

The well-known parasite, mistletoe (*Viscum* spp.), is also a member of this family. It is a parasite living on trees and shrubs about the 6,000 ft. level and above. It does not do much harm to timber-trees.

84. SANTALACEAE

Trees, shrubs or herbs, often hemiparasites on the roots of other plants. Leaves entire, alternate or opposite, exstipulate. Inflorescence of axillary or terminal paniced cymes, or pedunculate heads. Flowers hermaphrodite or unisexual, actinomorphic. Perianth green or petaloid, adnate to the ovary, 3-6-lobed; lobes valvate or slightly imbricate, often bearded at the insertion of the filaments. Stamens the same number as the perianth-lobes and opposite to them, inserted at their bases; filaments short; anthers 2-locular, opening by longitudinal slits. Disk present, epigynous. Ovary inferior or half inferior, 1-locular; style more or less simple; ovules 1-3, pendulous from a basal, central or erect placenta. Fruit indehiscent, a nut or drupe, containing a single seed. Seed with a copious fleshy endosperm; embryo straight.

A number of genera are found in India and these may be separated by means of the following key.

Leaves present:

Leaves opposite ... 1. *Santalum*

Leaves alternate:

Spinous trees:

Male flowers in catkin-like spikes ... 2. *Scleropyrum*

Male flowers in tomentose panicles ... 3. *Pyrularia*

Not spinous:

Root-parasites ... 4. *Osyris*

Parasitic on trunk or branches ... 5. *Henslowia*

Leaves absent ... 6. *Phacellaria*

1. *Santalum* Linn. *S. album* Linn., the Sandalwood tree, is a small parasitic tree with drooping branchlets. The leaves are evergreen, with a tinge of yellow. The bark is reddish-brown or dark-brown, smooth in young trees, rough with deep vertical cracks in old trees. This tree is of importance because of the

¹ See Turrill, W. B. *Kew Bulletin*, 1920, p. 267.

hard close-grained oily heartwood, which is found in branches and roots as small as 1 in. in diameter. While the usual height attained by the tree is not more than 50 ft., in favourable places the height is much more than this. The tree appears to flourish in the drier parts of Madras State between 2,000 and 3,000 ft. C. E. C. Fischer brings forward cogent arguments¹ to show that it is unlikely that the sandalwood tree is indigenous in India, and that it was introduced probably at an early date from Timor or some other place in Malaysia. This is borne out by the fact that the tree can grow in many other parts of India which have different climates from that of the Mysore tableland. It grows at Saharanpur and at Dehra Dun in Uttar Pradesh. All that it appears to need is a suitable host. In this respect the parasite may be unlucky, for the possible hosts of sandal are classified as good, bad, indifferent or definitely dangerous. Most species of the *Anacardiaceae* are fatal to the parasite and it is also killed in a year or two by *Erythrina indica*, *Carica papaya* and *Sapindus trifoliatus*. Strangely enough, *Strychnos nuxvomica* is a reasonably good host, although the bitter principle in the tissues of *Strychnos* is communicated to the sandal. This phenomenon has also been observed in the case of other hosts which possess glucosides or alkaloids in their sap. The sandal tree is also of interest because it is attacked by a virus disease, unknown outside India, termed spike-disease, which is always fatal. Much work has been done in recent years on various aspects of this disease, such as the method of infection, the nature of the cause and the vector, if any. It has long been considered that the disease is due to a virus and that it is transmitted from tree to tree by an insect, but it was not until 1941 that the insect vector was isolated. In that year Rangaswami and Griffith demonstrated that the insect responsible is most likely *Jassus indicus* (Walk.). Attempts to discover a host which will kill the virus which is the cause of spike have so far not been successful, though many hosts have been tried with this object in view.

2. *Scleropyrum* Arnott. *S. wallichianum* Arn. is a small tree with thick sharp conical axillary spines, small reddish flowers and a large drupe. It is found in the evergreen forests of the Western Ghats and also in Burma, where another species, *S. ridleyi* Gamble, is found at Mergui.

3. *Pyrularia* A. DC. *P. edulis* A. DC. is a small to middle-sized thorny tree found in the evergreen climax forests of the Khasi and Naga Hills and also in the eastern Himalayas at an elevation of 4,000-6,000 ft. The fruit is edible.

4. *Osyris* Linn. *O. wightiana* Wall. is a parasitic evergreen shrub with a very wide distribution in India and Burma.

¹ *Journal Bombay Nat. Hist. Soc.*, 1939.

5. *Henslowia* Bl. is a small genus of root parasites found in the eastern Himalayas, Assam Hills and Burma.

6. *Phacellaria* Benth. The chief claim to fame that this genus possesses is that its species are parasites upon parasites. The plants are small and leafless and are usually found growing on species of *Loranthus*.

42. RHAMNALES

Trees, shrubs or climbers; flowers actinomorphic, hermaphrodite or polygamo-dioecious, small; ovary superior or sunk in the disk; stamens the same number as and opposite to the petals; embryo straight; endosperm copious or scanty.

85. RHAMNACEAE 86. ELAEAGNACEAE

87. AMPELIDACEAE

85. RHAMNACEAE

Trees or shrubs, often spinescent, often scandent (*Gouania*, *Ventilago*, *Helinus*). Leaves simple, alternate or opposite, entire or toothed. Stipules small or absent, sometimes transformed into thorns. Inflorescence of fascicles of flowers or of collections of flowers cymosely arranged, usually axillary. Flowers hermaphrodite or rarely unisexual, regular, small, greenish. Calyx often tubular, 4-5-lobed; lobes valvate. Disk present and very conspicuous, lining the calyx-tube, perigynous. Petals 4-5, sometimes absent, free, inserted at the mouth of the calyx-tube or on the disk. Stamens 4-5, opposite to the petals and inserted with, and often embraced by, them; anthers 2-locular, opening by slits, dorsifixed, versatile. Ovary free or buried in the disk, or more or less adnate to the calyx-tube, 2-3-4-locular; styles equal in number to the loculi, more or less connate, shortly lobed; ovules usually solitary (occasionally two), erect, anatropous. Fruit often a drupe, sometimes winged (*Ventilago*), occasionally a capsule. Seeds with copious endosperm and large straight embryo.

Not a very important family from the point of view of pure forestry, but as some of the genera and species are important desert species they must be considered. This is a moderately large family with representatives scattered over the temperate and tropical regions of the world.

As far as India is concerned the following is a key to the important genera.

Erect trees or shrubs:

Fruit drupaceous, stone 1-4-locular:

Leaves 3-5-nerved; stipules spiny ... 1. *Zizyphus*
Leaves penniveined; stipules not spiny ... 2. *Berchemia*

- Fruit baccate containing 2-4 pyrenes:
 Disk thin, lining the calyx-tube ... 3. *Rhamnus*
 Disk fleshy, filling the calyx-tube:
 An unarmed tree; peduncle axillary, fleshy in the fruit ... 4. *Hovenia*
 Spiny shrubs; flowers sessile in terminal and axillary
 spikes or panicles ... 5. *Sageretia*
 Shrubs climbing by means of tendrils:
 Fruit a dry, winged, 1-seeded indehiscent fruit ... 6. *Ventilago*
 Fruit a capsule:
 Leaves toothed; capsule winged ... 7. *Gouania*
 Leaves entire; capsule not winged ... 8. *Helinus*

1. *Zizyphus* Juss. A genus containing a number of species which are erect spiny trees or scrambling shrubs. The fruit is a red or yellow drupe which is usually fleshy and is edible. The leaves are very coriaceous, distichous with three (rarely five) basal nerves. The stipular thorns are peculiar in that one is curved and the other straight. *Z. incurva* Roxb. is a small tree of the Himalayas and Naga Hills and is readily recognized from the horizontal bands of stout prickles on the stem. *Z. jujuba* Lam., the Ber tree, is very well known all over India, not only for its fruits, but also the many uses to which the tree can be put in dry areas. The branches are lopped for fodder and the leaves are fed to the *tassar* silkworm. It can stand a high degree of drought and the thorny branches make good fences. According to Troup, it is occasionally of importance silviculturally, because it is a good colonist and subsequently more important and better trees can grow protected by it. The lac-insect can be reared upon the bark, which is itself a source of tannin.

2. *Berchemia* Neck. Two species of this genus are found in the Indian Peninsula; both are large shrubs. *B. lineata* DC. is found in dry habitats from 5,000-9,000 ft. in the western Himalayas and Baluchistan. In Baluchistan this plant is cropped by goats to such an extent that it is reduced to a sprawling shrub a few inches high with a thick root-stock and very small leaves.

3. *Rhamnus* Linn. Shrubs or small trees of no particular importance.

4. *Hovenia* Thunb. A small deciduous tree with pubescent shoots. This is not an indigenous tree, but was apparently introduced into northern India for its edible fruit. The actual fruit is a small berry but the ramifications of the inflorescence swell into an irregularly and unevenly oblong fleshy mass, variously bent, which is sweet and aromatic (Brandis).

5. *Sageretia* Brongn. A genus containing unarmed or spinescent shrubs.

6. *Ventilago* Gaertn. A small genus of climbing plants. The fruits are quite distinctive, consisting of a subglobose indehiscent nut, seated on or partly enclosed by the persistent calyx-tube and prolonged into a linear coriaceous wing. *V. maderaspatana* Gaertn. is a powerful climber with dark-coloured stems, covered with cracked bark, found all over India and Burma. The flowers possess a very strong odour. The bark of the root contains the drug emodin, a stomachic, tonic and stimulant.

7. *Gouania* Linn. A small genus of shrubs, often climbing by terminal tendrils. The flowers are arranged in sessile clusters on an axillary or terminal axis and are quite ornamental. The fruit is a 3-winged capsule seated on the finally pendulous axis.

8. *Helinus* C. E. Mey. A very easy genus to spot in the forest on account of the tendril which is coiled in one plane and with not more than one revolution. *H. lanceolatus* Brandis is the only species found in India, where it is widespread. It also occurs in Burma.

86. ELAEAGNACEAE

Trees or shrubs, sometimes scandent, often spinescent, covered with copious silvery or rust-coloured scales or stellate hairs. Leaves (in Indian genera) alternate, entire, exstipulate. Inflorescence of solitary or fasciculate flowers, or of racemes or spikes. Flowers hermaphrodite or polygamous, sometimes dioecious, yellow or white, often scented. Calyx gamosepalous, tubular, constricted and persistent round the ovary, 2-4-lobed; lobes valvate or of two sepals in *Hippophaë*. Petals absent. Stamens double the number of the calyx-lobes or sepals in the male flowers, and opposite or alternate with them, equal in number and alternate in the hermaphrodite and polygamous flowers; anthers 2-locular, introrse, opening by longitudinal slits; no staminodes in the female flower. Ovary sessile at the base of the calyx, 1-locular; ovule one, basal, erect; style terminal, linear, stigmatose on one side. Fruit indehiscent, entirely enclosed within the lower part of the perianth, which becomes fleshy when the seed ripens. Seed with scanty or no endosperm; embryo straight.

The two genera in the family can easily be separated by this key.

- | | | |
|---|-----|---------------------|
| Flowers bisexual; perianth 4-fid | ... | 1. <i>Elaeagnus</i> |
| Flowers unisexual, usually dioecious; perianth of the male flower 2-partite, of the female flower 2-fid | | 2. <i>Hippophaë</i> |

1. *Elaeagnus* Linn. This genus is easily recognized in the field from the leaves alone, these being thickly covered with silvery peltate scales. There are six species in India and Burma.

Evergreen scrambling or climbing shrubs:

Perianth tube cylindric, about twice as long as broad or a little less ... *E. conferta*

Perianth tube ellipsoid, swollen in the middle, attenuated at the base and below the free lobes:

Tube broadly urceolate, nearly as broad as long

E. kologa

Tube urceolate, clearly much longer than broad:

Perianth three or more times longer than broad; whole flower up to 0.36 in. long ... *E. indica*

Perianth less than three times as long as it is broad, the flower about 0.24-0.28 in. long ... *E. latifolia*

Deciduous trees or shrubs:

Deciduous tree; endocarp bony ... *E. hortensis*

Deciduous shrub; endocarp coriaceous ... *E. umbellata*

E. conferta Roxb. found in Bombay, Bengal, Nepal, Burma.

E. kologa Schlecht. is a plant of south India.

E. indica Serv. is also a plant of south India.

E. latifolia Linn. is confined to Ceylon.

E. hortensis M. Bieb. This middle-sized tree is cultivated in Baluchistan for the sake of its sweet red globose drupes. The silvery leaves and fragrant flowers make this tree a desirable addition to a garden.

E. umbellata Thunb. is a much-branched thorny shrub often found in sandy places in the plains of Assam and also in the Himalayas up to 10,000 ft. The fruit is eaten.

2. *Hippophaë* Linn. There are two species of this genus in India.

Leaves clothed below with silvery or rusty scales

H. rhamnoides

Leaves clothed below with stellate hairs; midrib more or less covered with rusty scales ... *H. salicifolia*

H. rhamnoides Linn. is a large thorny dioecious shrub sometimes reaching the status of a small tree, which is found in the inner valleys of the Himalayas, 8,000-11,000 ft. The fruit is very acid but can be eaten when boiled with sugar. The wood is used in Kumaon for fuel and charcoal. The branches are often used to make temporary hedges for fields. This species is most variable in the size and scaliness of the leaf and R. N. Parker¹ recognizes three good varieties.

H. salicifolia D. Don is a shrub, very similar to, but rather larger than, *H. rhamnoides*. It seems to prefer somewhat moister localities than the latter.

¹ In *A Forest Flora for the Punjab with Hazara and Delhi*, p. 435.

87. AMPELIDACEAE

Shrubs or climbers, nodose or jointed, often with watery juice. Leaves petiolate, simple, palmate, digitate or imparipinnate, alternate or the lower sometimes opposite; stipules petiolar or absent. Inflorescence of leaf-opposed racemes, spikes, cymes or panicles. Flowers actinomorphic, small, hermaphrodite or unisexual. Calyx small, entire or 4-5-toothed or lobed. Disk present, often fleshy. Petals 4-5, free, or connate at the base in *Leea*, caducous, valvate. Stamens 4-5, opposite to the petals, inserted at the base of the disk; anthers 2-locular, dehiscing by longitudinal slits; filaments short and distinct or united below into a globose cup. Ovary 2-6-locular; loculi 1-2-ovuled; style short; stigma capitate or peltate. Fruit a berry, 1-6-locular. Seeds with copious endosperm sometimes ruminant; embryo small.

A large family of few genera but many species, the majority of which are indigenous in damp and hot climates, but representatives are also to be found at considerable altitudes in the Himalayas. The flowers of this family can be compared with those of *Rhamnaceae*; the arrangement of petals and stamens is the same.

The following is a key to separate the genera.

Climbing plants; stamens free; ovary 2-locular	<i>Vitis</i>
Erect shrubs; stamens connate and adnate to the petals;	
ovary 3-6-locular	... <i>Leea</i>

The genus *Vitis* has been divided up into a large number of separate genera by Planchon.¹ These genera are now usually accepted in modern floras but as the genus is not of much importance from the forester's angle, no key is given to these genera or to the numerous species contained in them. These species are twiners to very large climbers which can overtop the tallest trees. The leaves are either simple or trifoliate, more often pedately 5-9-foliate with stipules adnate to the petiole. The tendrils are leaf-opposed. The flowers are described as polygamo-dioecious. The fruits are often edible. *Vitis vinifera* Linn. is, of course, the cultivated grape. *Cissus repanda* Vahl (*Vitis repanda* Wight et Arn.) and *Vitis planicaulis* Hook f. contain a large amount of potable water in the stem. The rare parasite *Sapria himalayana* Griff. grows upon the roots of *Cissus* (*Vitis*) *elongata* Roxb.

The other genus, *Leea* Linn., is easily recognized by the large pinnate leaves and the pith in the stem. Some of its species grow into small trees, but the majority are shrubs which avoid climax forest and, for the most part, are to be

¹ In Alphonse and Casimir de Candolle, *Monographiae Phanerogamarum*, vol. V.

found in savannah or in waste places. *L. umbraculifera* C. B. Cl. is one species that does penetrate into the understorey of the climax evergreen. The lac-insect is cultivated on a number of the species.

43. RUTALES

Trees or shrubs ; leaves often gland-dotted ; flowers hermaphrodite, rarely dioecious, actinomorphic, rarely zygomorphic ; ovary superior, seated on a disk ; stamens equal to or double the number of the petals ; embryo straight or curved ; endosperm present or absent.

88. RUTACEAE 89. SIMARUBACEAE 90. BURSERACEAE

88. RUTACEAE

Trees or shrubs, very rarely herbs (*Peganum*, *Boenninghausenia*, *Ruta*, etc.). Leaves compound, often unifoliate by reduction, mostly gland-dotted, exstipulate, opposite or alternate. Inflorescence of axillary or terminal cymes or panicles, occasionally of racemes (*Dictamnus*), never spikes. Flowers usually hermaphrodite and regular, very rarely zygomorphic (*Dictamnus*). Sepals 4-5, imbricate, free or connate. Petals 4-5, imbricate, mostly free, rarely united. Stamens 4-5 or eight or ten, rarely more (*Citrus*, *Aegle*) or six (*Boenninghausenia*); filaments free, hypogynous; anthers 2-locular, introrse, opening by longitudinal slits; connective often glandular at the apex. Disk present within the stamens, crenate or lobed. Ovary superior, syncarpous and 4-5-locular or sometimes the carpels free towards the base, or altogether free; ovules usually two in each loculus; styles free or connate; stigmas terminal, entire or lobed. Fruit a capsule, berry or drupe. Seeds with or without endosperm; embryo curved.

The leaves and other organs of the species of this family possess numerous cavities in the tissues which are filled with ethereal oils which are visible, when the leaves are held up to the light, as translucent dots. Crushed leaves have usually an aromatic smell, and this combined with the pellucid dots and alternate arrangement of the leaves are very characteristic of the family. The Rue, *Ruta graveolens* Linn., is widely cultivated in India (according to Burkill, in every Bombay garden), where it is used as a stimulant and medicinal plant. The orange, grape-fruit, pumelo, all species of *Citrus*, are cultivated everywhere for their succulent fruits. *Aegle marmelos* Corr., the Bael, and *Limonia acidissima* Linn. (*Feronia elephantum* Corr.), the Wood Apple, are cultivated trees: the soft pulp of the fruit is made into a popular sherbet.

The members of this family are of little importance from the point of view of the forester. Owing to the presence of ethereal oils in the tissues they may be, in the future, of considerable importance as the source of minor forest-products. For example, *Skimmia laureola* Hook f. contains an oil which is of value, the only bar to its exploitation being the difficulty of assuring supplies of the leaves at a reasonable cost.

Many of the species of genera of this family are common as undergrowth in the forests of India and Burma: mention may be made of *Clausena pentaphylla* DC., *Acronychia pedunculata* Miq. (*A. laurifolia* Bl.), *Glycosmis pentaphylla* Corr. (now split into many species), *Micromelum minutum* Wight et Arn. (*M. pubescens* Bl.) with pretty dark-red flowers, *Murraya paniculata* Jack (*M. exotica* Linn.), a common shrub with pretty white flowers and foetid leaves, and *Murraya koenigii* Spreng. the leaves of which are used to flavour curries. *Evodia meliaefolia* Benth. is a tree of medium size in Bengal and Assam. It is easily recognized in the forest by its open crown, gland-dotted leaflets, fruits, and by the fact that the stem, when struck with the back of a kukri, emits a clear ringing sound. The compound leaves of *Evodia* are opposite and are thus easily recognized, as the other genera (except *Melicope*, a small tree or shrub of the Nilgiris) have alternate leaves. *Vepris bilocularis* Engl. (*Toddalia bilocularis* W. et A.), with trifoliate leaves, is a tree which reaches some size in the forests of the Western Ghats. *Zanthoxylon rhetsa* DC. (including *Z. budrunga* Wall.) is a large tree, with large pinnate leaves, of the evergreen forests of eastern and western India. The base of the stem is covered with blunt conical processes from wide woody bases. These can be struck off with a smart blow. The remainder of the bark is soft and corky, a characteristic which doubtless enables this tree to withstand forest fires. The wood is yellow, as the name of the genus suggests. The pith persists in the stems and these eventually become hollow and are used sometimes as water-pipes in Assam. The fruit contains seeds which taste like pepper when ripe. They are used in curries.

89. SIMARUBACEAE

Trees or shrubs, often with bitter bark. Leaves alternate or rarely opposite, pinnate, rarely 1-3-foliate (*Harrisonia*), 2-foliate (*Balanites*) or simple (*Samadera*), without pellucid glandular dots, exstipulate. Inflorescence of lateral simple or corymbose racemes or fascicles, axillary panicles or pedunculate umbels. Flowers small, unisexual or polygamous, rarely hermaphrodite, regular. Calyx 3-5-lobed or partite; lobes valvate or imbricate. Petals 3-5, rarely absent or connate into a tube (always present and free in Indian species), imbricate or valvate. Disk present, annular or cup-shaped, entire or lobed. Stamens inserted at the

base of the disk, equal to or double the number of the petals, rarely numerous; filaments free, glabrous or more often hairy, sometimes with a scale at the base; anthers 2-locular, opening by a longitudinal slit. Carpels 2-5, completely free, or connate at the base only, or cohering by the styles only, or completely united into a 2-5-locular ovary; styles 2-5; ovules usually solitary, rarely two or more, axile. Fruit usually of fleshy or dry drupes, or rarely of samaras (*Ailanthus*). Seeds pendulous, with scanty endosperm or endosperm absent; embryo with thick cotyledons, straight or curved.

This family is closely allied to *Rutaceae* and differs from it mainly in the absence of oil-glands and in its tendency towards unisexuality in the flowers.

The family is not of very much account in the forests of India; there are several genera, however, of which some notice must be taken.

The following is a key to the important genera.

- Leaves simple ... 1. *Samadera*
- Leaves compound:
 - Leaves 2-foliolate; flowers hermaphrodite; stamens 10; spiny plant ... 2. *Balanites*
 - Leaves imparipinnate or 3-foliolate:
 - Fruit a samara ... 3. *Ailanthus*
 - Fruit not a samara:
 - Fruit of 1-4 fleshy drupes supported by the persistent calyx and petals ... 4. *Picrasma*
 - Fruit not as above:
 - Leaves 3-foliolate ... 5. *Harrisonia*
 - Leaves imparipinnate; leaflets 4-6 pairs 6. *Brucea*

1. *Samadera* Gaertn. One species of this genus, *S. indica* Gaertn., is found in tidal swamps. It is a small evergreen tree with a very characteristic flat pear-shaped fruit. The seeds act as an emetic. They also contain an oil which is said to be of value in the treatment of rheumatism. An infusion of the leaves is a good insecticide and is deadly to termites.

2. *Balanites* Del. This small deciduous tree is an inhabitant of the drier parts of India and Burma, common in open country on stiff clay-soil associated with other thorny xerophytes. Spines are often present in the axils of the leaves and they themselves frequently bear leaves. The fruit is distinctive, being an ovoid drupe, 2 in. long, with five distinct grooves. The hard tubercled stone is surrounded by an offensive-smelling pulp. An oil can be expressed from the seeds.

3. *Ailanthus* Desf. There are three species of this genus in India, all of which grow into enormous trees with clean cylindrical boles. The leaves of the species wither red.

These may be separated by the following key.

Leaflets toothed:

Basal teeth glandular; samara twisted at the apex

A. glandulosa

Basal teeth not glandular; samara twisted at the base

A. excelsa

Leaflets entire:

Samaras 4-5 in. long

... *A. grandis*

Samaras 2.5-3 in. long

... *A. triphyssa*

Ailanthus glandulosa Desf. is a Chinese tree but is found frequently planted in northern India. It is known as the Tree of Heaven. *A. excelsa* Roxb. is a peninsular tree often planted and is very similar to the former, but has no gland-tipped teeth to the leaflet. The large panicles of flowers give off a foetid odour. *A. grandis* Prain is an enormous tree found in Assam and on the foot-hills of the Himalayas. *A. triphyssa* (Dennst.) Alston, (*A. malabarica* DC.) is a tree of the Western Ghats forests of Madras State. Although these trees are found in the evergreen climax forests of the wetter parts of India, their regeneration is not good in these forests. Troup attributes this to the intolerance of the seedling for weed-growth and lack of light. The seeds of these species greatly resemble the pods of various species of *Dalbergia* and isolated samaras have occasionally been identified as *Dalbergia* species. The wood is white and soft and is useless for structural work or for use out of doors; it does, however, make a very good plywood.

4. *Picrasma* Blume. There are two species of this genus found in India. One, *P. quassioides* Benn., with pubescent leaves and inflorescence and pentamerous flowers, is found in the outer foot-hills of the north-west Himalayas. The other, *P. javanica* Blume, is a glabrous small tree of eastern India, its foliage resembling that of *Pongamia pinnata* (Linn.) Merr. The fruits of *Picrasma* are quite characteristic. The drupes appear to be seated on a platter formed of the calyx and petals. The Quassia wood of Jamaica (*Picrasma excelsa* Pl.) is used in European medicine as a pure tonic, its active substance being the glucoside quassiin. *Picrasma quassioides* Benn. contains the same glucoside and the Japanese pharmacopoeia allows its use as a substitute for Quassia wood.

5. *Harrisonia* R. Br. A small genus of shrubs and trees with spiny prickles. *H. perforata* Merr. (*H. bennettii* Hook. f.) and *H. brownii* A. Juss. occur in the Andamans and Burma. The leaves of the latter (digitately 3-foliate) all turn yellow before falling. The flowers of this species are rather large and pink.

6. *Brucea* Miller. Two species of this small genus are found in eastern India and Burma. All parts of the plants are

extremely bitter but the seeds are the bitterest. The bitter principle is said to be very efficacious in the treatment of dysentery. The leaves are imparipinnate and the flowers are extremely minute. *B. amarissima* Desv. (*B. sumatrana* Roxb.) is an evergreen shrub of Assam and Burma.

90. BURSERACEAE

Resinous trees or shrubs. Leaves alternate, very rarely opposite, exstipulate, imparipinnate, 3-foliate or rarely 1-foliate; leaflets rarely pellucid-punctate, the lowest pair sometimes simulating foliaceous stipules. Inflorescence of axillary long or short panicles or fasciculate on arrested branches. Flowers hermaphrodite or unisexual, actinomorphic. Calyx 3-5-fid or -partite; lobes imbricate or valvate in the bud. Petals 3-5, imbricate or valvate in the bud, erect or spreading, free or variously connate. Disk present, annular or cupular, free or adnate to the calyx-tube. Stamens usually twice as many as the petals, sometimes equal in number; filaments free, inserted at the base or margin of the disk, glabrous, subulate; anthers often versatile, 2-locular, dehiscing by a longitudinal slit. Ovary superior, 2-5-locular, ovoid or globose, usually contracted into the short style; ovules two, rarely one in each loculus, axile. Fruit an indehiscent drupe with 2-5 pyrenes, or a capsule. Seeds exalbuminous; cotyledons folded and also twisted (contortuplicate).

A tropical family mainly found in America, but it is also represented in India. A number of the species in this family can be very easily raised from cuttings.

Five genera of this family require notice. They can be separated by the following key.

Fruit a capsule containing 3 pyrenes ... 1. *Boswellia*
Fruit drupaceous:

Disk cup-shaped:

Disk adnate to the calyx; pyrenes 1-5, bony, pitted,
1-seeded ... 2. *Garuga*

Disk free; pyrenes combined, one only seed-bearing
3. *Commiphora*

Disk annular, usually lobed:

Petals valvate; pyrenes 1-3, free, covered with pulp
4. *Protium*

Petals imbricate; pyrenes 1-3, combined, without pulp
5. *Canarium*

1. *Boswellia* Roxb. The only Indian species is *B. serrata* Roxb.; a small deciduous tree of the hotter and drier parts of India. It sometimes occurs pure but is often to be found associated with *Sterculia urens* Roxb. The bark is thick, and greenish-white in colour. This species appears to be very

resistant to jungle fires and regenerates itself freely in grassland or abandoned hill-fields.

2. *Garuga* Roxb. *Garuga pinnata* Roxb. is a middle-sized deciduous tree. The leaves turn a bright-red before falling, a fact which is useful in the forest in separating it from *G. gamblei* King, which it otherwise much resembles. This tree is a common associate of members of the mixed deciduous forests and is able to withstand forest fires. When cut the bark exudes a large quantity of white gum for which no use has yet been found. The fruits are eaten and the bark is useful in tanning.

3. *Commiphora* Jacq. (*Balsamodendron* Kunth). There are several species of this genus in India. They are all small trees or spiny shrubs, yielding aromatic resins, and are inhabitants of the hotter and drier parts of India.

The following is a key to the species.

Spiny shrubs or trees; leaves 1-3-foliolate:

Leaflets 1-3, dentate above, obovate	...	<i>C. mukul</i>
Leaflets 3, broadly crenate	...	<i>C. berryi</i>

Unarmed species: leaves imparipinnate:

Leaflets glabrous; terminal leaflets long-petioled	<i>C. caudata</i>
Leaflets pubescent; terminal leaflets sessile	<i>C. pubescens</i>

C. berryi Engl. (*Balsamodendron berryi* Arn.) is a thorny fragrant tree, which is very commonly used all over southern India as a hedge-plant. It is a bush of dry, arid areas and has a smooth silvery-purplish bark.

C. caudata (Wight et Arn.) Engl. (*Protium caudatum* Wight et Arn.) is a deciduous tree found in the dry forests of the Deccan, and is said to be almost a weed in the fuel coupes. It is useless for firewood and the leaves are avoided by cattle. This tree is probably more easily raised from cuttings than any other in India. For that reason and also for its thick crown, it deserves to be widely grown as a shade, avenue or road-side tree. The green bark peeling off in papery flakes and the 3-5-foliolate leaves make this tree easy to identify.

4. *Protium* Burm. *Protium serratum* Engl. (*Bursera serrata* Colebr.). This moderate-sized to large deciduous tree is common and gregarious throughout the greater part of India. Its associates are the usual associates of the mixed deciduous forest: *Anogeissus latifolia*, *Lannea grandis*, *Sterculia urens*, etc. The leaves turn yellow in December and fall soon afterwards. The flowers appear before the leaves. The fruits are edible.

5. *Canarium* Linn. This genus of (mostly) evergreen balsamiferous trees is confined to eastern India and Burma, except for one species which is found in Madras State in the climax forests of the Western Ghats. They are all fine tall handsome trees with striking dark-green foliage. Wounds in the bark exude

large quantities of a clear resinous substance which dries hard. This exudate can be burned and is used as incense or to drive mosquitoes out of dwelling-houses. When the shoots send out new leaves the latter are of a beautiful red colour (very striking in the case of *C. strictum* Roxb.). The bark is very hard and when struck with the back of a dao gives out a metallic sound.

The following is a key to the species.

Leaflets entire:

Leaflets ferrugineous-tomentose ... *C. euphyllum*

Leaflets glabrous:

Leaflets 6-7 pairs ... *C. bengalense*

Leaflets 2-4 pairs:

Leaflets 7.5 in. long; blaze red

C. coccineo-bracteatum

Leaflets 4.5 in. long; blaze brown

C. mannii

Leaflets serrate or crenulate:

Blaze orange, exuding a dark gum ... *C. sikkimense*

Blaze brown or reddish-brown ... *C. resiniferum*

Of these *C. bengalense* Roxb., *C. resiniferum* Brace and *C. sikkimense* King are confined to Assam and Bengal; *C. strictum* Roxb. to Madras State; *C. euphyllum* Kurz to the Andamans and Burma and the other two exclusively to the Andamans.

44. MELIALES

Trees or shrubs; flowers usually hermaphrodite, actinomorphic; petals valvate; ovary superior; stigma often disciform; stamens with connate filaments (except *Cedrela*) and sessile anthers; embryo straight or curved; endosperm present or absent.

91. MELIACEAE

Large or small trees, or rarely undershrubs, with hard, coloured, often scented wood. Leaves alternate, exstipulate, generally pinnate, rarely simple (*Turraea*); leaflets in most genera quite entire. Inflorescence of terminal or axillary panicles. Flowers often scented, hermaphrodite, or polygamous (*Chisocheton*), actinomorphic. Calyx generally small, 4-5-fid or partite; lobes imbricate. Petals 4-5, sometimes 3-7, free or sometimes connate, contorted or imbricate, or adnate to the staminal tube and valvate. Stamens generally 8-10, rarely five, very rarely numerous; filaments inserted outside at the base of a hypogynous disk, connate by their margins into a more or less complete tube, which is entire or toothed or lacinate, very rarely free (*Cedrela*); anthers sessile or subsessile within the tube, included or exserted,

dehiscing by a longitudinal slit. Disk often cup-shaped, annular or sheathing, usually free. Ovary 3-5-locular, superior; style simple; stigma disciform or pyramidal; ovules two in each loculus, sometimes 8-12, rarely numerous. Fruit a drupe (*Melia*), or a capsule (*Chukrasia*, *Dysoxylum*), or a berry (*Walsura*). Seeds with or without albumen.

This is one of the more important families from the forester's point of view. It is also one of the easiest to spot when in flower. The alternate compound leaves, combined with tetramerous or pentamerous flowers and a staminal tube, place a plant in this family with certainty. There is one important exception, the genus *Cedrela*, which has stamens which are completely free.

The following is a key to the important genera found in India.

Translucent glands in the leaves ... 1. *Chloroxylon*

Leaves opaque:

Filaments of the stamens connate into a tube, at least as far as the insertion of the anthers:

Loculi of the ovary with 1-2 ovules; disk sheath- or cup-shaped:

Leaflets toothed:

Petals adhering for half their length to the staminal tube; capsule hairy ... 2. *Munronia*

Petals free:

Drupe several-locular; stigma entire

3. *Melia*

Drupe unilocular; stigma 3-toothed

4. *Azadirachta*

Leaflets entire:

Style long; flowers and staminal tube oblong:

Stigma 5-6-toothed; leaves 3-foliate; fruit a drupe ... 5. *Sandoricum*

Stigma entire; leaves simple or pinnate; fruit a capsule:

Flowers up to 3 in. long; leaves simple

6. *Turraea*

Flowers much shorter; leaves pinnate:

Ovule 1 in each loculus; disk a short sheath ... 7. *Chisocheton*

Ovules 2 in each loculus; disk a long sheath ... 8. *Dysoxylum*

Style short or absent:

Flowers 5-merous:

Anthers 5; fruit dry, indehiscent

9. *Aglaia*

Anthers 10; fruit fleshy

10. *Lansium*

Flowers 3-4-merous; anthers 3-10; capsule dehiscent ... 11. *Amoora*

Loculi of the ovary with more than 2 ovules:

Seeds winged:

Seeds winged at both ends ... 12. *Soymida*

Seeds winged at one end only:

Petals 0.15-0.25 in.; capsule 3-6 in. long

13. *Swietenia*

Petals 0.5 in.; capsule 1-1.5 in. long

14. *Chukrasia*

Seeds not winged; littoral trees

15. *Xylocarpus*

Filaments free, at least in the upper third:

Loculi with 1-2 ovules:

Loculi at least 5; drupe 5-furrowed, scarlet

16. *Cipadessa*

Loculi 1-2:

Fruit an indehiscent drupe ...

17. *Walsura*

Fruit dehiscing by 2 valves ...

18. *Heynea*

Loculi with 8-12 ovules; fruit a capsule; seeds winged

19. *Cedrela*

1. *Chloroxylon* DC. One species only of this genus, *C. swietenia* DC., the Satinwood, occurs in India. Easily recognized by its light-green pinnate leaves and the gland-dotted leaflets, it is a common tree in the dry deciduous forests of the Indian Peninsula and will grow on poor soil in areas subjected to very high temperatures. It is sometimes found associated with its close relative, *Soymida febrifuga*, on poor calcareous soils with nodules of kanker. The wood is greatly valued for ornamental work and furniture.

2. *Munronia* Wight. A small shrub of the evergreen forests of south and eastern India and Burma. The pink flowers are very handsome.

3. *Melia* Linn. There are two species of the genus in India both of which are important trees. *Melia azedarach* Linn. is one of our handsomest trees and is known to Europeans as the Persian Lilac. It is a moderate-sized deciduous tree and the ample terminal panicles of fragrant flowers which have a dark-purple staminal tube and pale mauve petals are very striking. Various parts of the tree are medicinal and a preparation of the fruits is used in America as an insecticide or flea-powder. It is commonly cultivated in India as a road-side tree. Its rapid powers of growth recommend it as a fuel-tree where that commodity is scarce. Many tea-gardens in Assam have taken up its cultivation. *Melia composita* Willd. (*M. dubia* Cav.) is a very similar tree, but its flowers are white; it is often seen as a shade-tree in plantations and is widespread in India from the plains up to 6,000 ft. This species grows very rapidly and can be used for reafforestation when speed is all-important. The wood is excellent for tea-boxes as it is durable and easily worked.

4. *Azadirachta* A. Juss. Everybody knows *Azadirachta indica* A. Juss., the *Neem* or *Margosa*. The oil has some repute in Indian medicine, as a febrifuge and anti-rheumatic. The timber is also of value, being moderately heavy and very hard. The most remarkable fact about this tree is its adaptability to various habitats. It is considered to be of great value as a road-side tree in dry and arid places and it will also grow in areas with a high rainfall. Its growth is rapid but not so fast as that of *Melia azedarach*. It is a general belief in India that the mere presence of this tree keeps an area free from malaria. The oil can be, and often is, used as an anthelmintic for cattle.

5. *Sandoricum* Cav. There is one species of the genus, viz. *S. koetjape* Merr. (*S. indicum* Cav.) in India and Burma. It is widely cultivated in Burma and is also found in the Andamans. It is valued as a shade-tree but the rather insipid fruit is also eaten. The yellow velvety globose fruit and the coriaceous trifoliate leaves which turn bright-red before falling distinguish this tree from all others.

6. *Turraea* Linn. *T. villosa* Benn., a large shrub or small tree, is only found in the Western Ghats forests. The flowers, about 1.5 in. long, are white and sweet-scented.

7. *Chisocheton* Blume. A genus of trees, some of which may reach 50 ft. in height, confined to the eastern side of India. It is very easy to recognize it in the forest from the large (3 in. in diameter) orange or orange-red, globose pear-shaped fruits in drooping bunches. There are 2-4 reddish-brown glossy seeds in each fruit. Moreover the rhachis of the compound leaf is produced beyond the last pair of full-sized leaves and sometimes bears a couple of abortive leaflets. There are about five species, which are of no value as timber.

8. *Dysoxylum* Blume. Large, sometimes very large, umbrageous trees, with long imparipinnate or paripinnate leaves, which are evergreen. They grow scattered in the evergreen climax forests of all parts of India and are often found on the banks of streams. The leaflets are entire and oblique at the base. Two species, *D. procerum* Hiern. and *D. hamiltonii* Hiern., both trees of eastern India, are very easy to recognize in the forest because of their flowers which are strongly scented like garlic. The fruit is a 4-5-valved loculicidal capsule, like that of *Chisocheton*, and the ripe fruits hang in bunches from the branches. *D. binectariferum* Hook f., a large tree of Assam, Bengal and western India, has glossy dark-purple seeds; those of *D. malabaricum* Bedd., a tree of the Western Ghats, are dark-brown in colour. The scent of the wood of the latter is rather like that of cedar. The timber furnished by these species is not of much account.

9. *Aglaia* Lour. A small genus of trees or shrubs with imparipinnate leaves. The indumentum, when present, is either stellate or lepidote. These species are readily recognized when in flower

from the very minute flowers, or by the fruits, which are indehiscent. *A. roxburghiana* Hiern. is the only one of any forest importance. It grows in the evergreen climax forests of the Western Ghats. The bark is light-brown in colour and the wood bright-red.

10. *Lansium* Rumph. The genus is closely allied to *Aglaia*, from which it differs in the ten anthers and fleshy fruits. There is only one species of the genus wild in India, *L. anamallayanum* Bedd., but *L. domesticum* Jack, the *Doekoe* of Java, is sometimes cultivated in southern India for its excellent fruit.

11. *Amoora* Roxb. Evergreen trees, sometimes of large size, with coriaceous glossy green leaves which are imparipinnate. The leaflets are entire. These trees are usually found in evergreen climax forests. As in *Chisocheton* and *Dysoxylum*, the fruit is a globose loculicidal capsule which contains red glossy seeds.

The following is a key to the species.

- Blaze with milky juice ... *A. wallichii*
- Blaze without milky juice (or juice slightly milky in *A. canarana*):
 - Leaves glandular punctate ... *A. canarana*
 - Leaves opaque:
 - Leaflets alternate ... *A. lawii*
 - Leaflets opposite:
 - Capsule 2.5 in. in diameter ... *A. cucullata*
 - Capsule 1.5 in. in diameter ... *A. rohituka*

A. wallichii King is an evergreen tree found in Assam, Bengal, Burma and the Andamans. It grows up to 80 ft. tall and has a circular bole. The blaze is pinkish-green with a few beads of milky juice. The wood is red and heavy and is widely used.

A. canarana Benth. et Hook. is an evergreen tree of the Western Ghats which is readily recognized by its pink blaze and glandular-punctate leaflets.

A. lawii Bedd. This is a medium-sized tree found in the forests of the Western Ghats. The obovoid fruit, 0.75 in. long, is indehiscent and is densely yellowish-lepidote.

A. cucullata Roxb. This tree is found in Burma, Bengal and doubtfully in Assam, growing on tidal river-banks. It sends up numerous root-suckers from the mud which act as pneumatophores.

A. rohituka Wight et Arn. This evergreen middle-sized tree with spreading crown has been removed from the genus *Amoora* and placed in *Aphanamixis* Blume by some botanists, on account of the sexes being not only in different flowers but on different trees. Hence this tree, which is widespread in Malaysia, is called *Aphanamixis polystachya* Parker in those

parts. It is found in all but the driest parts of the country but is most common in the evergreen forests of Assam, Bengal and Burma. The timber is red, hard and heavy and is suitable for decorative work.

12. *Soyimida* A. Juss. *S. febrifuga* A. Juss., the sole representative of this monotypic genus, is a large almost deciduous tree with a straight bole covered with thickish greyish-brown bark exfoliating in large plates. The leaves are greyish-green in colour, paripinnate and alternate. It is common in the dry forests of the Indian Peninsula. It can stand both drought and fire. The septifragally dehiscent fruit contains numerous seeds, each of which is winged at both ends. The bark is bitter and is used in Indian medicine as a febrifuge. The wood takes a fine polish and is suitable for decorative purposes.

13. *Swietenia* Linn. Two species of this exotic have been largely cultivated as ornamental trees and as a timber-crop in Madras State. *S. mahogani* Linn. is the true Mahogany tree of Central America and Jamaica. *S. macrophylla* King has larger leaves and capsules and grows much more rapidly than the former. It was first raised from seed obtained from Honduras in 1872.

14. *Chukrasia* A. Juss. This genus is represented in India by *C. velutina* Wight et Arn. (*C. tabularis* A. Juss.), a tall tree which is widespread in the climax forests of eastern and western India as well as in Burma and the Andamans. Easily recognized in the forests from its rusty-brown deeply fissured bark with prominent lenticels and the new leaves being light-green in colour except the end pair which are reddish-pink. The fruit is an ellipsoid 2-4-5-valved capsule about 1.5 in. long. The timber is valuable.

15. *Xylocarpus* Koen. (*Carapa* Aubl.) A genus of evergreen trees which are always found on coasts or in tidal swamps. The leaves are paripinnate with coriaceous leaflets. The fruit is a globose capsule with a fleshy pericarp, dehiscent by four valves. Three species of *Xylocarpus* Koen. are found in India and Burma.

The following key will be of use in separating them.

Leaves broadly ovate-acute	...	<i>X. molluccensis</i>
Leaves elliptic or obovate, rounded at the tip:		
Leaves obovate	...	<i>X. granatum</i>
Leaves elliptic-oblong	...	<i>X. gangeticus</i>

X. molluccensis (Lam.) Roem. (*Carapa molluccensis* Lam.). This is a littoral tree found on the coasts but not actually in mangrove swamps. The fruit is the size of an orange. Found in the Andamans.

X. granatum Koen. (*Carapa obovata* Blume). This tree, on the other hand, is an inhabitant of the mangrove forests, of which it is an integral part. The fruit is very large being 7-10 in. in

diameter. Found in the Andamans and coastal forests of the continent.

X. gangeticus (Prain) C. E. Parkinson. A small to middle-sized tree which is an inhabitant of the mangrove swamps. It is distinguished from the last-named by its habit of sending up pneumatophores out of the mud. It is different from the other two species by being deciduous; all the leaves turn yellow before falling. Found in the Andamans only.

The wood of these species is said to be durable but it is difficult to get pieces of sufficient length for any particular purpose. The bark is used as a source of tannin.

16. *Cipadessa* Blume. One species of this genus, *C. baccifera* Miq. (*C. fruticosa* Blume), is found in central and western India, extending to Burma and beyond. It is found growing gregariously in dry forests and in Madras State on laterite hills. It is a bushy shrub.

17. *Walsura* Roxb. A genus of small trees with a wide distribution. The leaves are imparipinnate and usually glaucous beneath. One species, *W. piscidia* Roxb., an inhabitant of the Western Ghats, is used to poison fish.

18. *Heynea* Roxb. A small to middle-sized tree with thin ash-coloured bark, covered with depressed lenticels, found everywhere in India and Burma. The leaves are imparipinnate, white-glaucous beneath. This characteristic, combined with the fact that the fruit is a 1-locular capsule containing an orange-red seed enclosed in an arillus, makes it comparatively easy to identify in the forest.

19. *Cedrela* Linn. A genus of very large handsome trees, widely spread over India and Burma, valued for their excellent timber which is of use for decorative purposes.

The important species can be distinguished by the following key.

Leaflets serrate	...	<i>C. serrata</i>
Leaflets entire:		
Bark exfoliating in flakes	...	<i>C. febrifuga</i>
Bark not exfoliating:		
Leaflets glabrous:		
Leaflets 7 pairs; seeds evenly winged at both ends		<i>C. toona</i>
Leaflets 9 pairs; seeds with a longer wing above than below	...	<i>C. microcarpa</i>
Leaflets pubescent on both surfaces	...	<i>C. kingii</i>

C. serrata Royle. This is a deciduous west Himalayan tree, also found in Manipur and Upper Burma. The wood is red with an unpleasant odour.

C. febrifuga Blume. A tall tree of the Naga Hills and Upper Burma. The form with warty capsules is found in the

hill-forests of Bengal. The wood is dark-pink, turning red after exposure, soft, open-grained, but durable (Cowan). The upper wing of the seed is rather shorter than the lower. This is the species which is used by the Nagas to make tables, paddy-pound-ing boards, etc., as it does not warp or crack.

C. toona Roxb. This tree is common all over India and is often planted as an avenue tree, where it does well up to old age, when it becomes rather unsightly. The timber has some repute as a furniture wood. It is pink or pinkish-white in colour with a strong smell. The blaze is deep-pink with white streaks and a characteristic odour, the *Toon* smell. Plantations of this species are often browsed by deer. The twig-borer *Hypsipyla robusta* causes great damage in young plantations but the tree is able to resist its attacks and after some years shows no signs of ever having been parasitized. Also called *Toona ciliata* Roem.

C. microcarpa C. DC. A tree of the central to the eastern Himalayas and on to Burma. It is similar to the preceding and has the same characteristic smell.

C. kingii C. DC. A medium-sized tree of the lower hill-forests of Bengal. Its uses are very much the same as those of the preceding species. The leaflets, pubescent above and below, distinguish it from the other species.

45. SAPINDALES

Trees or shrubs ; flowers often polygamous or unisexual, actinomorphic or zygomorphic ; ovary superior with 1-2 ovules in each loculus ; stamens often double the number of petals, sometimes inserted within the disk ; embryo curved or crumpled ; endosperm usually absent.

92. SAPINDACEAE 93. ACERACEAE 94. SABIACEAE
95. ANACARDIACEAE

92. SAPINDACEAE

Trees, shrubs, undershrubs or climbers. Leaves alternate, simple or compound, stipules rarely present. Inflorescence of unilateral cymes arranged in racemes or panicles. Flowers inconspicuous, actinomorphic or zygomorphic, really unisexual but apparently polygamo-dioecious. Calyx of five usually unequal sepals, free or variously connate, imbricate or rarely valvate. Disk present, often fleshy and ring-like and bearing glandular swellings opposite the petal insertions, sometimes unilateral, shorter, or wanting in the posterior portion of the flower. Petals usually five, sometimes absent, or four, free, often furnished on the inner surface below with scales or tufts of hair which conceal the nectaries. Stamens often ten, in two whorls of five, often eight by suppression, inserted usually within the disk ; filaments subulate,

occasionally unilateral; anthers 2-locular, dehiscing by a longitudinal slit. Ovary 3-locular (occasionally 1-4-locular) superior, entire, lobed, or divided nearly to the base; style terminal or from between the lobes; ovules 1-2, or rarely many in each loculus, with axile placentation. Fruit a capsule, nut, berry or drupe, frequently winged. Seed often arillate, without endosperm.

The majority of *Sapindaceae* are easily recognized in the forest when in flower by having the disk outside not inside the stamens and by the eight stamens in a pentamerous flower with a 3-locular ovary. Several species produce excellent fruits, of which the Litchi, *Nephelium litchi*, is perhaps the best-known. The fruits of several contain a soap-like material and are used instead of soap.

Key to the important genera of *Sapindaceae*

- | | | |
|--|-----|--------------------------------------|
| Climbing herbs with tendrils and biternate leaves; disk unilateral | ... | 1. <i>Cardiospermum</i> |
| Erect trees and shrubs: | | |
| Leaves opposite and digitate | ... | 2. <i>Aesculus</i> |
| Leaves alternate: | | |
| Leaves simple | ... | 3. <i>Dodonaea</i> |
| Leaves compound: | | |
| Leaves trifoliate | ... | 4. <i>Allophyllus</i> |
| Leaves pinnate: | | |
| Rhachis of leaf winged | ... | 5. <i>Filicium</i> |
| Rhachis of leaf not winged: | | |
| Petals absent | ... | 6. <i>Schleichera</i> |
| Petal present: | | |
| Fruit a capsule: | | |
| Capsule inflated | ... | 7. <i>Harpullia</i> |
| Capsule not inflated | ... | 8. <i>Mischocarpus</i> |
| Fruit indehiscent: | | |
| Fruit not lobed: | | |
| Fruit smooth | ... | 9. <i>Lepisanthes</i> |
| Fruit echinulate or tubercled | | 10. <i>Nephelium</i>
(sensu lato) |
| Fruit lobed: | | |
| Ripe carpels quite distinct | | 11. <i>Sapindus</i> |
| Ripe carpels united at the base | | 12. <i>Erioglossum</i> |

1. *Cardiospermum* Linn. *C. halicacabum* Linn. is a wiry climber with ternate leaves, climbing by means of tendrils. The fruit is an inflated 3-locular capsule with membranous reticulate valves. This small climber grows rapidly and can become a pest in plantations.

2. *Aesculus* Linn. There are two species of Horse Chestnut in India, *A. indica* Colebr. and *A. punduana* Wall. The leaflets of the former are petiolate, those of the latter almost sessile. The inflorescence is interesting in that it consists of a long erect panicle made up of numerous short-peduncled scorpioid cymes. The fruit is a leathery capsule without spines.

3. *Dodonaea* Linn. *D. viscosa* (Linn.) Jacq. is a large shrub or small tree with young shoots, buds etc. covered with a bright sticky yellow resinous exudation. Leaves shining as though varnished. The fruit is a broadly 2-winged capsule. This shrub is found in the drier parts of India and Burma, often on the sea-coasts. The timber is extraordinarily hard but pieces of it are not available in any useful size. The fruits are quite characteristic, forming a circular flattened capsule of two halves, each with a rounded wing, papery in texture. This species makes a neat hedge.

4. *Allophylus* Linn. A genus of small shrubs or trees with trifoliate leaves and flowers in narrow spiciform axillary racemes. The fruits are thinly fleshy, dull orange-red in colour and contain one large seed.

5. *Filicium* Thw. The one species in India, *F. decipiens* Thw., is an inhabitant of the evergreen climax forests of the Western Ghats. It can be recognized at once from the winged rhachis of the pinnate fern-like leaf. The bark is reddish-grey and rough. This tree is frequently planted for ornament.

6. *Schleichera* Willd. *S. oleosa* (Lour.) Merr. (*S. trijuga* Willd.), the Indian species, is a handsome dense-foliaged tree found in the central and western parts of India and in Burma. The young foliage is a fresh light-green or a deep-red. The bark is rather thin with a blaze which is at first pink, slightly mottled-yellow, afterwards deepening to brown. The timber is said to be good but it is not often used as this tree is preferred as a host for the lac-insect. The leaves are uncommonly like those of the English oak, *Quercus robur*.

7. *Harpullia* Roxb. *H. arborea* Radlk. (*H. imbricata* Thw.), the Indian representative of this genus, is a middle-sized tree with a clean bole. The bark is rather light-coloured and the blaze with a chlorophyll layer, then brown, becoming paler within. The fruits are inflated capsules, scarlet in colour, many of which hang pendant from the branches.

8. *Mischocarpus* Blume. A genus of evergreen trees formerly included in *Cupania* Linn. All of them are inhabitants of the evergreen climax forests of Assam and Burma.

9. *Lepisanthes* Blume. A small genus with two species in India and one in the Andamans. *L. tetraphylla* Radlk. (*Hemigyrosa canescens* Thw.) is a crooked evergreen tree of central and western India. The bark is light-coloured and the blaze rather soft, brittle, thick, pale-brown or orange. The fruit is a

3-angled 3-locular capsule, yellow-tomentose outside; valves hairy within.

10. *Nephelium* Linn. Radelkofer in his monograph on the *Sapindaceae* divides *Nephelium* into the following three genera (Indian) which may be separated as follows:

Seed-coat free:

Calyx deeply lobed; lobes overlapping ... *Euphoria*

Calyx with very short valvate lobes ... *Litchi*

Seed-coat firmly attached ... *Nephelium*

Euphoria Commers. *E. longana* Lam. (*Nephelium longana* Roxb.) is a common tree in the evergreen forests of the Western Ghats both in Bombay State and Madras State. The bark is brown and rough; the blaze with layers of orange-brown and cream.

Litchi Sonn. *L. chinensis* Sonn. (*Nephelium litchi* Camb.) is the well-known fruit cultivated everywhere in India.

Nephelium Linn. *N. stipulaceum* Bedd. is a common tree in the forests of the Western Ghats. The lower pair of leaflets are small, oblique, curved or reniform and simulate stipules.

11. *Sapindus* Linn. A genus of trees, middle-sized to large, which are very distinct when in fruit. The fruit consists of 1-3 fleshy indehiscent distinct carpels. The pericarp contains saponin and the fruits are frequently used as a substitute for soap. The two best-known species are *S. emarginatus* Vahl and *laurifolius* Vahl, both of which were sunk in *S. trifolius* Hiern. non Linn. in the *Flora of British India*. These trees are found in central and western India. *S. detergens* Roxb. is cultivated in northern India and is said to be doubtfully indigenous.

12. *Erioglossum* Blume. *E. rubiginosum* Blume is a small evergreen tree with dark-coloured bark and light-brown blaze. The branchlets, young leaves and inflorescence are covered with a rusty-golden tomentum. The white flowers in long racemes followed by drupes nearly 1 in. long, yellow or reddish and finally dark-purple in colour, make this tree an easy one to identify in the field.

93. ACERACEAE

Trees with perulate buds. Leaves opposite, petiolate, simple, often palmilobed and palminerved, rarely entire; stipules absent. Inflorescence of axillary or terminal fascicles, racemes or corymbs. Flowers actinomorphic, unisexual, or often polygamous; pedicels with a caducous bract. Calyx of 4-5 imbricate sepals. Petals 4-5, inserted on the edge of an annular disk, shortly clawed, imbricate. Stamens 4-10, often eight, inserted on the disk, inside or outside it, hypogynous or perigynous; filaments free, shorter in the bisexual, longer in the male flower;

anthers 2-locular, introrse, oblong, basifixed or versatile, dehiscing by longitudinal slits; rudimentary ovary often present in male flowers. Ovary free, sessile, 2-locular, 2-lobed, compressed contrary to the septum; ovules two in each loculus, with axile placentation; style simple; stigma bifid. Fruit of twin symmetrical samaras. Embryo without albumen; cotyledons foliaceous.

This family consists of three genera and over a hundred species. The genus *Acer* is found in the Himalayas or in the mountainous regions separating Assam from Burma. The flowers generally conform to the formula $S_5, P_5, A_4+4, G(2)$. The fruit is characteristic and serves to separate this genus from all others. A number of the Himalayan species have simple lanceolate or oblong-lanceolate leaves. One of the best-known is perhaps *A. oblongum* Wall. which is valued as an avenue tree in Dehra Dun. The other species are typical Maples with lobed leaves. They are inhabitants of the climatic climax forest of the hills and are often readily picked out among the other trees by reason of their handsome light-green foliage. The wood of these species is as a rule close-grained, white and sometimes beautifully figured. The wood does not seem to be much used but it should be a good turnery wood. The Sycamore of Europe, *Acer pseudoplatanus* Linn., has been introduced into the Punjab hills. *A. saccharinum* Wang., the Sugar Maple of North America, is tapped for the sake of its sugary sap.

Dobinea Buch.-Ham., a genus which appears in the *Flora of British India* under *Sapindaceae* and in Brandis, *Indian Trees* under *Anacardiaceae*, fits into this family. It is a small shrub of the Naga, Mishmi and Sikkim Hills, with an indehiscent fruit, adnate to a round or obovate emarginate penninerved thinly membranous bract, 0.5 in. in diameter (Brandis).

94. SABIACEAE

Trees or shrubs, erect, scandent or sarmentose. Leaves alternate, simple or pinnate, entire or serrate, penninerved; stipules absent. Inflorescence of 1 - few-flowered axillary peduncles or of ample axillary or terminal panicles. Flowers hermaphrodite or polygamo-dioecious, small, actinomorphic or zygomorphic. Calyx 4-5-partite; lobes imbricate. Petals 4-5, opposite to, or alternate with, the sepals, imbricate in the bud. Disk present, annular, lobed. Stamens 4-5, inserted at the base or on top of the disk, opposite to the petals, free or adnate to them, all fertile in *Sabia*; in *Meliosma*, two fertile adnate to the smaller petals, three sterile opposite the larger petals; filaments of fertile stamens thick, clavate or obcuneate, those of the sterile scale-like; anthers 2-locular with a thick connective, dehiscing by a transverse slit or a deciduous calyptra. Ovary sessile, 2-3-

locular, compressed or 2-3-lobed (in *Sabia* of more or less distinct carpels); styles more or less united; ovules 1-2 in each loculus horizontal or pendulous. Fruit of 1-2 flat indehiscent ripe carpels (*Sabia*) or a drupe (*Meliosma*). Seed without albumen. Embryo with rugose or contorted cotyledons.

There are only two genera of this small family in India. One is *Sabia* Colebr., the species of which are climbing or sarmentose shrubs found in the plains and in the hills to an altitude of 10,000 ft. The species in fruit can easily be recognized by the fruiting carpels. They are borne on a peduncle either singly or in pairs, are often flat and broadly obovate or reniform.

Meliosma Blume is a genus of small trees which are widespread in India. There are about nine species. All of them have simple leaves except *M. pinnata* Roxb., a small tree of Bengal and Assam. At flowering time the minute flowers are produced in very large panicles which cover the whole tree. The leaflets of this tree are all concave upwards, and if the petiole be broken a small red spot can be seen on the broken surface.

95. ANACARDIACEAE

Large or small trees with schizogenous resin-passages in the bark. Leaves alternate, very rarely opposite, simple or compound; stipules absent. Inflorescence in racemes, fascicles, spikes or panicles, axillary or terminal. Flowers usually actinomorphic, mostly small, hermaphrodite or unisexual, often fragrant. Calyx of 3-7 lobes; lobes sometimes accrescent (*Parishia*). Disk present, often fleshy. Petals 3-7 or absent (*Pistacia*), often accrescent (*Melanorrhoea*, *Swintonia*), inserted at the base or on the disk. Stamens often double the number of the petals, rarely more (*Melanorrhoea*) or equal in number; filaments free, filiform; anthers 2-locular, versatile, opening by longitudinal slits. Ovary superior (inferior in *Drimycarpus*), 1-locular; styles 1-3, often widely separated; ovule solitary, pendulous from the apex or adnate to the ovary wall, or pendulous from a basal funicle. Fruit usually a drupe, sometimes seated on a fleshy hypocarp. Seed without endosperm.

This large family is well represented in India and species of it are found in hills and plains. The majority of the species possess an acrid juice in the bark which turns black after it has dried out. Many persons get painful swellings, often accompanied by high fever, if the juice is allowed to touch the skin, others are totally unaffected. Others again are so sensitive that they are affected if they approach a tree that has been blazed. These swellings may develop into open sores which are extremely difficult to heal and may be sufficiently severe to put the sufferer out of action for some time. *Rhus toxicodendron* Linn. is a North American plant called Poison-ivy and its juice has the same effect upon certain people. An alcoholic solution of lead

acetate for external, not internal, application, is recommended to get rid of the poisonous effects. The aborigines of the Philippines dry a portion of the branch of the offending tree, burn it at sundown, and allow the smoke to touch the affected parts, whereupon all pain is supposed to be relieved. The fruit of several species is prized and the juice of others is famed as a lacquer.

Key to the genera of *Anacardiaceae*

Leaves simple:

Petals enlarged in fruit:

Fruit stalked ... 1. *Melanorrhoea*

Fruit sessile ... 2. *Swintonia*

Petals not enlarged in fruit:

Ovary inferior:

Spurs on petioles; margins of leaves not undulate

3. *Holigarna*

No spurs on petioles; margins of leaves undulate

4. *Drimycarpus*

Ovary superior:

Sterile flowers many, on long hairy pedicels

5. *Rhus*

Sterile flowers not many:

Stamens double number of petals:

Drupe on a fleshy hypocarp ... 6. *Anacardium*

Drupe on a persistent enlarged calyx

7. *Buchanania*

Stamens as many as petals:

One stamen only fertile ...

8. *Mangifera*

All stamens fertile:

Stamens 4, fruit a drupe ...

9. *Nothopogia*

Stamens 5-6; fruit on a fleshy hypocarp

10. *Semecarpus*

Leaves pinnate:

Flowers petaliferous:

Ovary 1-locular:

Tall evergreen trees; sepals enlarged in fruit (Andamans) ... 11. *Parishia*

Deciduous trees; fruit a drupe:

Fruit not more than 0.3 in. long ...

5. *Rhus*

Fruit 0.5 in. long, succulent ...

12. *Lannea*

Ovary 4-5-locular ...

13. *Spondias*

Flowers apetaliferous ...

14. *Pistacia*

1. *Melanorrhoea* Wall. *M. usitata* Wall. is a large deciduous tree common in the open deciduous forests of Burma. It is also found in Manipur. It is known as the Burmese Lacquer tree, it being the source of a black gum—the famous Martaban

varnish—with which almost every vessel in a Burmese house, intended to contain solid or liquid food, is lacquered' (Kurz). In the fruit the petals are persistent, about 2 in. long, much veined, purplish and wing-like, stellately spreading about the globular drupe which is seated on a stipe.

2. *Swintonia* Griff. A small genus of evergreen trees, principally found in Burma, but one species, *S. floribunda* Griff., at least penetrates into southern Bengal. It is a middle-sized tree with ash-grey bark and a blaze that is said to be pinkish. The fruit is rather like that of *Melanorrhoea* but here the drupe is sessile amid the enlarged (2 in. long) purplish petals.

3. *Holigarna* Ham. Trees, often lofty, which are codominants in the evergreen climax forests of eastern and western India. They all possess black acrid juice in the bark. *H. grahamii* Hook. f. is easy to recognize in the forest by its striking leaves which are light-green, oblanceolate in shape and suddenly widened above the middle.

4. *Drimycarpus* Hook. f. There is only one Indian species in this genus, *D. racemosus* Hook. f., an evergreen tree found in Assam and southern Bengal. The leaves are characteristic and enable this tree to be identified with certainty in the forest. They are lanceolate in shape, very leathery and thickened on the undulate margins. The ripe drupe is red in colour.

5. *Rhus* Linn. A genus of small trees and shrubs of which about ten species are found in India. They are often trees which are the first to appear on abandoned hill-cultivation and for this reason are important. Moreover a lacquer can be obtained from some of them and the bark can be used for tanning. *R. cotinus* Linn., known as the Wig Plant in Europe, because of the numerous sterile hairy long pedicels of the fruiting panicle, is a trans-Indus tree. This small tree possesses a dark-yellow, streaked and mottled heartwood which is used for small carvings and inlays. The leaves and bark are used in tanning. *R. semialata* Murr. is a small deciduous tree very common in the Naga Hills in abandoned hill-fields. There is a sticky white milk in the bark of this tree which does not turn black. The leaves turn beautiful red and orange autumn shades before falling.

6. *Anacardium* Linn. *A. occidentale* Linn., the Cashew-Nut, is a small tree indigenous in South America, but is cultivated very widely in parts of India, particularly in Madras State. The cashew-nut, the kernel of the kidney-shaped drupe, has become an important article of export from the Malabar coast. The acrid juice which is present in all parts of the plant can be destroyed by heat, hence the nuts are always roasted before being offered for sale. The fruit is supported by a fleshy acid edible hypocarp which is formed by the swollen torus and calyx-base. This part of the fruit can be eaten raw but it does contain

an irritant substance which causes coughing. This is a tree useful for the reclamation of sand dunes.

7. *Buchanania* Spreng. The best-known species in India of this genus is *B. lanzan* Spreng. (*B. latifolia* Roxb.). It is found in deciduous forests throughout the greater part of India and Burma. The bark of this tree is dark-grey or black and is divided regularly into small rectangular plates somewhat resembling crocodile-hide, red inside (Troup). It is of importance economically because of its fruits, which are known as *Calumpang* nuts in the trade. They are extensively used for making sweetmeats. The bark yields a gum. The wood is not good but the tree is valued for the rapidity with which it covers bare arid slopes. *B. angustifolia* Roxb. is another species found in Madras State differing from the former in its glabrous panicles. The nuts are said to be superior to those of *B. lanzan* as a substitute for almonds in sweet-making.

8. *Mangifera* Linn. The Mango tree, *M. indica* Linn., is grown extensively in India for its fruit. The cultivated varieties yield a fruit which is much superior to that of the wild tree, which is stringy and full of turpentine and may even be poisonous. The wild tree is found in the evergreen climax forests of India. Students are not likely to be puzzled by the flowers of this tree, unless the leaves are absent, but it is as well to remember that the flower, though typically pentamerous, has only one fertile stamen; the filaments of the others may or may not be present.

9. *Nothopegia* Blume. A small genus of evergreen trees which are common in the underwood of the evergreen climax forests of the Western Ghats. The acrid juice of the bark eventually turns black. The leaves are oblong, coriaceous, with spaced secondary nerves.

10. *Semecarpus* Linn. f. A genus of trees with acrid juice. One species is ubiquitous in India and Burma, *S. anacardium* Linn., the Marking Nut tree. The fruit is used for marking clothes and is sold in the bazaars of India as a dry black drupe. For use as ink the juice of the drupe should be mixed with lime water.¹

Madras State has three species which can be separated by the following key.

Leaves and inflorescence pubescent ... *S. anacardium*

Leaves and inflorescence glabrous:

Petals 5 in male flowers; drupe 1 in. long

S. travancorica

Petals 3 in male flowers; drupe 0.5 in. long

S. auriculata

¹ There is a good illustration of the leaf and drupe in Brandis, *Indian Trees*, p. 208.

S. travancorica Bedd. is a very large tree somewhat resembling *Holigarna grahamii* in its light-green foliage, but the leaves are much larger. The bark is grey in colour blotched with black and when blazed exudes an acrid juice which eventually turns black. This tree is said to be common in the forests of Tinnevely and Travancore. *S. auriculata* Bedd. has a grey smooth bark and is found in the same localities.

The key to the Burmese species is as follows.

Nut enclosed in the hypocarp	...	<i>S. albescens</i>
Nut exserted from the hypocarp:		
Ovary pubescent:		
Hypocarp enlarged:		
Leaves obtuse	...	<i>S. anacardium</i>
Leaves acuminate	...	<i>S. pandurata</i>
Hypocarp small	...	<i>S. heterophylla</i>
Ovary glabrous:		
A tree	...	<i>S. panduriformis</i>
A shrub	...	<i>S. subracemosa</i>

The wood of all these species is useless. Two other species are found in the Andamans; *S. prainii* King with leaves 1 ft. long and *S. kurzii* Engler with leaves 2 ft. long.

11. *Parishia* Hook. f. *P. insignis* Hook. f. is a large evergreen tree confined to the Andamans and southern Burma. The bark is greyish, peeling off in flakes; blaze reddish with milky juice which is non-irritant and does not turn black. The fruit is characteristic, being coriaceous, 1-seeded, 0.5 in. in diameter, supported by four linear-oblong, reddish and pubescent wings 3-4 in. long.

12. *Lanea* A. Rich. *L. grandis* Engler (*Odina wodier* Roxb.), the only species, is a large deciduous tree; bark smooth in young trees, afterwards exfoliating in thin irregular rounded flakes; blaze crimson marked with pink and white. Easily recognized by the blaze and the subreniform red drupes.

13. *Spondias* Linn. *S. pinnata* (Linn.) Kurz (*S. mangifera* Willd.) is known as the Hog Plum. It is a moderate-sized deciduous tree with imparipinnate leaves. The leaflets have an intramarginal vein. The fruit is the size of a pigeon's egg with a fleshy exocarp, yellow when ripe. Small deer eat large quantities of the fallen fruit, regurgitating the indigestible woody stones which are left in a little heap on the forest floor. There is no doubt that the seeds are disseminated in this way.

14. *Pistacia* Linn. A deciduous tree, *P. integerrima* Stew., is the sole representative of the genus in our area, and it is confined in the wild state to the north-western Himalayas, but it is often cultivated in the plains of the Punjab. The young foliage has a beautiful red colour. The mature leaves often

carry monstrous galls, 6-7 in. long, which are sold in the bazaars under the name *Kakrasinghi*. These galls are used in indigenous medicine and are reputed to cure a variety of disorders ranging from tuberculosis and cough to dysentery and want of appetite. The wood is brown in colour, beautifully mottled with yellow and darker veins. It is, therefore, highly prized for furniture and its durability gives it a high reputation for constructional work.

Bouea burmanica Griff., known as the Marian tree, is largely cultivated in Burma and the Andamans for its yellow drupaceous fruit, 1.5 in. long. *Schinus molle* Linn., a small South American tree, is extensively planted in India for its handsome foliage. If a leaflet is broken up and thrown upon water, the fragments jerk about on the surface, being agitated by an ethereal oil which emerges from the pieces. According to Burkill this tree gives a Brazilian mastic. It is purgative and the fruits are used to make a refreshing drink. Piperine, an alkaloid, is contained in them.

Another cultivated tree which is likely to be met with is *Pleiogynium cerasiferum* Parker, an evergreen tree which has been planted in the northern parts of India, particularly at Saharanpur and Lucknow. The flowers are small but the leaflets of the imparipinnate leaves are 2-3 in. long, and 7-11 in number. It is a handsome tree and deserves to be more widely grown.

46. LOGANIALES

Trees or shrubs ; flowers hermaphrodite, actinomorphic ; ovary superior, 2-4-locular ; stamens epipetalous, alternate with the corolla-lobes or fewer (2) ; embryo straight ; endosperm present.

96. LOGANIACEAE 97. EHRETIACEAE

98. OLEACEAE

96. LOGANIACEAE

Trees, shrubs, often climbing, or herbs. Leaves opposite, simple, often connected by interpetiolar stipules or a raised line, sometimes stipules absent. Inflorescence cymose, of paniced spikes or racemes. Flowers hermaphrodite, actinomorphic. Calyx 4-5-merous, of free or connate sepals; sepals valvate in the bud, rarely imbricate. Corolla gamopetalous, hypogynous, 4-10-lobed; lobes imbricate, valvate or contorted. Stamens as many as the corolla-lobes, inserted on the tube alternate with the lobes; anthers 2-locular, introrse, opening by longitudinal slits. Ovary superior, 2-4-locular; ovules one (*Gardneria*) or more in each loculus, axile or ascending. Fruit a berry or drupe.

Seeds with a fleshy or cartilaginous endosperm; embryo straight.

Key to the genera of *Loganiaceae*

Ovules in each loculus numerous:

Fruit dehiscent, capsular:

Climbers ... 1. *Gelsemium*

Shrubs ... 2. *Buddleja*

Fruit indehiscent:

Leaves succulent; corolla-lobes contorted ... 3. *Fagraea*

Leaves coriaceous; corolla-lobes valvate ... 4. *Strychnos*

Ovule 1 in each loculus ... 5. *Gardneria*

1. *Gelsemium* Juss. *G. elegans* Benth. is a climber found in Assam, Manipur and Burma. The flowers are bright-yellow and are borne in terminal compound trichotomous cymes. This climber bears a remarkable superficial resemblance to climbing species of *Jasminum*, so much so that this mistake has been made even by experienced botanists when matching specimens in a herbarium. The fact that this genus has five stamens is quite sufficient to rule out the possibility of *Jasminum*. The chief interest of the plant lies in its roots and leaves, which contain an extremely virulent poison.

2. *Buddleja* Linn. A genus of shrubs, some of them with handsome fragrant flowers. None of them is of forest importance, but they are sufficiently handsome to excite the forest officer's curiosity.

The following is a key to the Indian and Burmese species (after Marquand).

Stamens inserted at or immediately below the mouth of the corolla-tube:

Flowers very large; corolla-tube 0.25-3 in. wide at the mouth ... *B. colvilei*

Flowers much smaller; corolla-tube not exceeding 0.14 in. in diameter at the mouth:

Ovary glabrous ... *B. longifolia*

Ovary tomentose:

Inflorescence a wide-spreading panicle

B. paniculata

Inflorescence an elongate spike-like panicle:

Flowers 0.3-0.4 in. long:

Inflorescence very dense; branchlets tetraginous, winged; calyx longer than diameter

B. macrostachya

Inflorescence very lax; branchlets subterete; calyx shorter than diameter

B. hookeri

Flowers 0.16-0.25 in. long ... *B. griffithii*

Stamens inserted in the middle portion of the corolla-tube:

Ovary glabrous:

Corolla-tube 0.08-0.1 in. long ... *B. asiatica*

Corolla-tube 0.16-0.18 in. long ... *B. neemda*

Ovary tomentose:

Panicle wide, spreading and few-flowered ... *B. crispa*

Panicle strict, spike-like ... *B. candida*

These plants are distributed as follows.

B. colvilei Hook. f. et

Thoms.: Sikkim and Chumbi Valley,

Tibet

This species reaches tree size and its handsome crimson flowers are very striking in the upper hill-forests of Sikkim.

B. longifolia Gagne.: Nepal, Sikkim

B. paniculata Wall.: Nepal, Assam

B. macrostachya Benth.: Assam, Burma

B. hookeri Marq.: Sikkim, Burma

B. griffithii Marq.: E. Bengal, Bhutan

B. asiatica Lour.: India, Burma

B. neemda Buch.-Ham.: N. W. India

B. crispa Benth.: N. W. Himalayas, Bhutan

B. candida Dunn.: Sadiya Frontier Tract, Assam

3. *Fagraea* Thunb. A genus of evergreen glabrous shrubs or trees often epiphytic, with handsome, often fragrant flowers. The opposite leaves are fleshy. Like the figs, species of this genus often start life as epiphytes and, having killed their supports, maintain a separate independent existence as erect trees.

The following is a key to the species.

Corolla-tube under 2 in. long:

Leaves up to 12 in. long; corolla-tube 0.5 in. long

F. racemosa

Leaves up to 6 in. long:

Corolla-tube 0.3 in. long

... *F. fragrans*

Corolla-tube over 0.5 in. long:

Corolla-tube 1-1.5 in. long

... *F. obovata*

Corolla-tube 0.75 in. long

... *F. khasiana*

Corolla-tube over 3 in. long:

Corolla-tube tubular; leaves broadly elliptic

F. carnosa

Corolla dilated at the throat; leaves obovate:

Flowers 5 in. long; funnel-shaped

... *F. auriculata*

Flowers 3.5 in. long; tubular

... *F. zeylanica*

F. racemosa Jack (*F. morindaefolia* Blume) is a shrub found

in low-lying swampy localities in the Andamans and possibly in Tenasserim. It is rather like a coffee-bush in general appearance but the funnel-shaped flowers and superior ovary easily distinguish this plant from the other.

F. fragrans Roxb. is a tall tree which is common in the Eng forests of Burma (*Dipterocarpus tuberculatus* Roxb.). The flowers on opening are pure-white and very fragrant but they turn a rather dirty-yellow as they age. The fruits are at first orange-coloured and then turn bright-scarlet. Flying-foxes come from far and wide to feed on the ripe fruits. The wood is hard and even-grained and finds local uses.

F. obovata Wall. is a bush or small tree which is found on the west coast and in the Nilgiris and again in north-east India and Burma. The wood is said to be of no particular value.

F. carnosa Jack, of Tenasserim, *F. zeylanica*, of Madras State and Ceylon, and *F. auriculata*, of Tenasserim, are small shrubby species of no account.

4. *Strychnos* Linn. There are a number of species of this important genus in India.

The following is a key to them (after Hill).

Corolla-tube very short; lobes longer than the tube:

Leaves trinerved¹ ... *S. aenea*

Leaves tripli- to 5-pli-nerved:

Corolla hairy outside ... *S. bicirrhosa*

Corolla glabrous outside ... *S. andamanensis*

Corolla-tube not short, equal to, or longer, than the lobes:

Corolla-lobes equal to the tube:

Corolla with long woolly hairs in the throat:

Anthers bearded at the base ... *S. laurina*

Anthers glabrous:

Ovary glabrous ... *S. potatorum*

Ovary hirsute:

Leaves trinerved ... *S. colubrina*

Leaves triplinerved ... *S. lenticellata*

Corolla without long woolly hairs but with bristles in the throat:

Bristles at the base of the corolla ... *S. axillaris*

Bristles on the middle of the tube ... *S. dalzellii*

Corolla-lobes much shorter than the tube:

Inflorescence terminating leafy branches:

Trees:

Leaves 5-nerved; anthers not apiculate; seeds orbicular, shining sericeous-hirsute ... *S. nux-vomica*

Leaves 5-7-nerved; anthers apiculate; seeds irregularly ovoid ... *S. nux-blanda*

¹ Trinerved means three-nerved from the base; triplinerved means three-nerved from above the base.

Shrubs or climbers:

Leaves triplinerved ... *S. cinnamomifolia*

Leaves trinerved ... *S. tubiflora*

Inflorescence from the axils of fallen leaves

S. wallichiana

The distribution of the species named above is as follows:

<i>S. aenea</i> A. W. Hill:	Assam, Madras State
<i>S. bicirrhosa</i> Lesch.:	Madras State
<i>S. andamanensis</i> A. W. Hill:	Andamans
<i>S. laurina</i> Wall.:	Burma
<i>S. potatorum</i> Linn. f.:	Madras State, Burma
<i>S. colubrina</i> Linn.:	Madras State
<i>S. lenticellata</i> A. W. Hill:	Madras State
<i>S. axillaris</i> Colebr.:	Bengal, Assam
<i>S. dalzellii</i> C. B. Cl.	Madras State
<i>S. nux-vomica</i> Linn.:	South and central India
<i>S. nux-blanda</i> A. W. Hill:	Assam, Burma
<i>S. cinnamomifolia</i> Thw.:	Assam, Madras State
<i>S. tubiflora</i> A. W. Hill:	Andamans
<i>S. wallichiana</i> Benth.:	Assam, Bengal

The genus *Strychnos* is chiefly of interest on account of the poison, strychnine, which some of the species possess. In addition to the strychnine, the alkaloid brucine is often also present. It is not every species which possesses the poison and it is of interest to note that the most poisonous of all, *S. nux-vomica*, is so similar to the harmless *S. nux-blanda* that it is difficult to tell the two apart.

S. nux-vomica Linn. is a large, handsome, evergreen or deciduous tree with a thin smooth yellowish-grey or blackish-grey bark. It is found in the Indian Peninsula and extends into Madhya Pradesh. It is very common in the moist monsoon forests of Bombay State. The seeds are collected and sold.

S. nux-blanda A. W. Hill is the Strychnine tree of Assam and Burma, very similar to the former, but the seeds do not contain any poisonous principle.

S. potatorum Linn. f. is a tree of the dry deciduous forests of the Indian Peninsula. The fruits contain a very large quantity of mucilage which when thrown into muddy water carries down the mud and clears the water.

5. *Gardneria* Wall. *G. ovata* Wall. is a large climbing shrub with yellow flowers, found in Madras State and Assam. The berry is scarlet. *G. angustifolia* Wall. is a similar shrub found only in the Khasi Hills.

97. EHRETIACEAE

Trees and shrubs, usually hispid. Leaves generally alternate, simple, entire, exstipulate, often with cystoliths. Inflorescence

of solitary flowers, or in panicles or corymbs. Flowers actinomorphic, hermaphrodite or polygamous. Calyx gamosepalous, persistent, 4-5-lobed; lobes valvate. Corolla gamopetalous, usually 5-lobed; lobes imbricate; throat naked or furnished with hairs, scales or protuberances. Stamens as many as the corolla-lobes, inserted on the tube alternate with the lobes; anthers 2-locular, opening by longitudinal slits. Ovary of two carpels, 2-locular, the loculi often divided by a false septum, entire or deeply 4-lobed; style terminal; ovules paired, erect or spreading from the central axis. Fruit a drupe (in the tree species) or of four nutlets. Seed with or without endosperm; embryo straight or curved.

Key to the woody genera of *Ehretiaceae*

- | | | |
|-----------------------|-----|-------------------------------------|
| Style terminal, 4-fid | ... | 1. <i>Cordia</i> |
| Style not 4-fid: | | |
| Style 2-fid; trees | ... | 2. <i>Ehretia</i> |
| Style simple; shrubs | ... | 3. <i>Rotula</i> (<i>Rhabdia</i>) |

1. *Cordia* Linn. A genus of trees common in both India and Burma.

The following key may be used to distinguish species.

Flowers white:

 Corolla small; tube hardly as long as the calyx:

 Leaves alternate or occasionally sub-opposite, usually with at least the basal pair of nerves opposite:

 Filaments villous at the base:

 Fruiting calyx not ribbed:

 Cystoliths not conspicuous on the upper-surface of the leaves:

 Leaves not tomentose beneath

C. dichotoma

 Leaves softly fulvous- or white-tomentose beneath

C. wallichii

 Cystoliths conspicuous as white dots on the upper-surface of the leaves:

 Under-surface of leaves glabrous; calyx glabrous

C. grandis

 Under-surface of leaves grey-tomentose; calyx tomentose

C. fragrantissima

 Fruiting calyx ribbed at the base:

 Leaves over 3 in. long:

 Leaves cordate or rounded at the base; corolla-tube glabrous within

C. macleodii

 Leaves cuneate or rounded at the base; corolla-tube very hairy within

C. vestita

 Leaves less than 3 in. long

C. domestica

 Filaments glabrous at the base ...

C. monoica

Leaves sub-opposite; basal nerves not opposite

		<i>C. rothii</i>
Corolla large; tube longer than the calyx		<i>C. octandra</i>
Flowers orange or orange-scarlet:		
Plant glabrous	...	<i>C. subcordata</i>
Plant hairy	...	<i>C. sebestena</i>

C. dichotoma Forst. f. (*C. obliqua* Willd.; *C. myxa* Roxb. et auct. non Linn.) is a middle-sized deciduous tree with a grey or brown bark with shallow longitudinal wrinkles; blaze buff changing to a dirty-green and finally to brown. This species has a very wide distribution in India and Burma and ascends in the hills to 5,000 ft. The leaves are used as cheroot-wrappers in Burma and the fruits are eaten. The wood is only moderately good and is used locally. The bark may be made into cordage.

C. wallichii G. Don is a medium-sized tree found in the moist deciduous forests of the Western Ghats. Its uses are the same as those of the former.

C. grandis Roxb. is a middle-sized tree with a fairly smooth grey bark; blaze pale-coloured, changing to a dirty-brown.

C. fragrantissima Kurz. A middle-sized to large deciduous tree found in Assam and Burma. The wood of the tree is brown, fragrant and beautifully mottled. Burkill states that the wood is used in Burma as a face powder, presumably after having been ground!

C. macleodii Hook. f. et Thoms. A small to middle-sized tree found in central India in dry deciduous forests. The bark is light-grey; blaze pale, turning brown. The heartwood is reddish-brown in colour and beautifully mottled. The wood is said to be even-grained and very hard.

C. vestita Hook. f. et Thoms. is a small deciduous tree with a crooked bole. The bark is greenish-grey with occasional deep, widely separated cracks, exfoliating in large woody scales in old trees. This tree is found in the sub-Himalayan tract from the Jhelum to the Sarda. The wood is hard, brown, streaked or mottled, very handsome, and is suitable for ornamental furniture (Troup).

C. domestica Roth (*C. myxa* var. *domestica* C. B. Cl.; *C. fulvosa* Wt.) is a shrub or small tree found in Madras State. The small white-pubescent leaves are characteristic of the species.

C. monoica Roxb. is a shrub or small gnarled tree found in central India and extending to the Deccan.

C. rothii Roem. et Schult. is a small tree with sub-opposite leaves. It is a tree of the drier parts of India, being found in the Punjab and on the ridge at Delhi, and in the Deccan and Carnatic. The bark is grey or brownish-grey with deep longitudinal furrows. The wood is brown, hard and streaked and should be in demand for ornamental work.

C. octandra A. DC. is a small tree found in Madras State. It is of no importance.

C. subcordata Lam. is a littoral species found in the Andamans and on the coast of Burma. It is a small tree with a cracked bark; blaze pale-pinkish, streaked. The flowers are handsome and conspicuous, bright-orange, and the tree is often cultivated in gardens. The wood is said to be very durable and deserves more notice.

C. sebestena Linn. is a small tree often seen in cultivation in gardens on account of its very handsome orange-red flowers.

2. *Ehretia* Linn. This genus contains a number of species in India and Burma.

Key to the species

Style single, bifid less than half-way down:

Leaves serrate ... *E. acuminata*

Leaves entire:

Leaves more than 3 in. long by 2 in. broad:

Flowers in axillary lateral or terminal lax cymes

E. laevis

Flowers in usually terminal, sometimes axillary, corymbose cymes ... *E. aspera*

Leaves usually less than 3 in. long by 2 in. broad:

Leaves ovate ... *E. pubescens*

Leaves not ovate:

Leaves elliptic or obovate ... *E. ovalifolia*

Leaves elliptic-lanceolate or oblanceolate
E. wightiana

Styles 2, or 1 slender and bifid to near the base

E. microphylla

E. acuminata R. Br. is a moderate-sized deciduous tree with grey longitudinally fissured bark, widespread in northern India, extending into Burma and the Chittagong Hill Tracts. The blaze is yellowish, hard. The leaves, plucked when young, are used for mixing with the brick-tea exported from China to Tibet, where the warmth, combined with the rich red liquor produced by these leaves, is said to be appreciated by the Tibetans.

E. laevis Roxb. is a small or moderate-sized deciduous tree with a smooth soft light-grey bark; blaze white with orange, yellow or brown streaks. In trees which have been frequently burned the outer bark exfoliates in small square or oblong flakes. The tree is common throughout the greater part of India in deciduous forests. The bark is chewed and colours the teeth red. The leaves can be used as fodder.

E. aspera Roxb. A deciduous shrub found in the dry parts of India, from the Punjab to the Carnatic.

E. pubescens Benth. is a small shrub.

E. ovalifolia Wight is a small branching tree with pale-brown branches, white flowers and red drupes.

E. wightiana Wall. is a small shrub found in the Western Ghats.

E. microphylla Lam. (*E. buxifolia* Roxb.) A small shrub common in south India, with fascicled, very coriaceous, small leaves and a scarlet globose drupe.

3. *Rotula* Lour. There is one representative of this genus, *R. aquatica* Lour. (*Rhabdia lycioides* Mart.) in India. This species is a gregarious prostrate shrub in the beds of streams and rivers where it often goes under water during the rains. The fleshy branches offer no resistance to the flow of water and, when pressed down upon the soil, sometimes take root. With *Homonoia riparia*, it often forms the only woody vegetation, below high-water level, in hill rivers and streams.

98. OLEACEAE

Trees, shrubs and climbers (*Myxopyrum*, *Jasminum*). Leaves opposite (alternate in a few species of *Jasminum*), simple or pinnate, exstipulate. Inflorescence of pedunculate bracteate fascicles of flowers, or of racemes or trichotomous panicles. Flowers actinomorphic, hermaphrodite, sometimes polygamous or dioecious, often fragrant. Calyx-tube small, truncate, 4-lobed (sometimes 4-9-lobed). Petals 4-11 or absent (*Fraxinus micrantha*), imbricate or induplicate-valvate. Stamens two, epipetalous or hypogynous; anthers apiculate, 2-locular; loculi back to back, opening by longitudinal slits; filaments usually short. Disk absent. Ovary superior, 2-locular; ovules two in each loculus, attached to the inner angle; style simple; stigma capitate or bifid. Fruit a berry, capsule, drupe or samara. Seeds usually more or less compressed, with endosperm; embryo straight.

Key to the genera of *Oleaceae*

Trees with pinnate leaves:

Fruit a loculicidal woody capsule ... 1. *Schrebera*

Fruit a 1-seeded winged nut ... 2. *Fraxinus*

Shrubs or trees with opposite simple leaves:

Fruit a capsule:

Leaves very rough ... 3. *Nyctanthes*

Leaves not rough ... 4. *Syringa*

Fruit drupaceous:

Petals connate ... 5. *Olea*

Petals free or connate in pairs ... 6. *Linociera*

Climbers:

Leaves 3-nerved ... 7. *Myxopyrum*

Leaves not 3-nerved ... 8. *Jasminum*

1. *Schrebera* Roxb. *S. swietenioides* Roxb. is a moderate-sized deciduous tree with opposite odd-pinnate leaves and terminal panicles of whitish flowers, closely covered with brown scales. The capsular fruits are also characteristic, being pyriform in shape, 2-valved, 2-locular, and about 2.5 in. long. The bark is nearly smooth, pale-grey, exfoliating in thin scales; blaze pale brownish-yellow with a grating or cheesy cut. This species is found in rather dry mixed deciduous forests, often on hilly ground, in the drier parts of India and Burma. The wood is hard and close-grained but does not appear to be much used.

2. *Fraxinus* Linn., the Ash, is represented in India by six species.

Key to the species

Inflorescence on the young shoots in the axils of the upper leaves and terminal:

Petals absent ... *F. micrantha*

Petals present:

Leaves serrate ... *F. floribunda*

Leaves entire ... *F. griffithii*

Inflorescence arising from the shoots of the previous year in the axils of fallen leaves:

Calyx absent; flowers racemose ... *F. excelsior*

Calyx present; flowers fascicled:

Rhachis winged ... *F. xanthoxyloides*

Rhachis not winged ... *F. velutina*

These trees can be recognized in the field even without leaves, flowers or fruit by the black buds of the following year's shoots. In fruit the winged nuts are distinctive.

F. micrantha Lingelsh. is a large deciduous tree with a grey bark, which is smooth on young, corky and furrowed on old stems. It is a west Himalayan tree and is found between 6,000 and 7,000 ft.

F. floribunda Wall., the Indian Ash. This large deciduous tree is common in the east Himalayas, in the Khasi and Naga Hills, and also in the hills of Burma. It is very similar to the last named species and the only difference between them seems to be that the former has no petals. The wood is moderately hard and tough and is used locally.

F. griffithii C. B. Cl. This is a deciduous tree which is very rare in India, having been found by Griffith in the Mishmi Hills. It is common in the Philippine Islands, Formosa, etc.

F. excelsior Linn. The European Ash, a large straight-stemmed deciduous tree, occurs wild in the western Himalayas at 7,000-10,000 ft. Troup says its distribution is very local in Hazara, Chamba and elsewhere on deep moist well-drained soil. It differs from the European form in possessing fewer leaflets and longer and more slender racemes. In India the bark is grey,

smooth on young stems, rough on older, becoming longitudinally deeply furrowed on old trees. The wood is extremely valuable and the supply can by no means equal the demand.

F. xanthoxyloides Wall. is a large shrub or small tree with a smooth grey bark which, in old trees, is dark and cracked. It is found in the valleys of the western Himalayas at lower elevations than the other species (3,000-5,000 ft.). It is locally very common and gregarious. It is usually associated with *Acer pentaponticum* and *Quercus ilex* and is characteristic of the inner dry valleys. The wood is hard, white and close-grained, and is used for tool-handles and walking-sticks.

F. velutina Torr. is an American tree which has been introduced into Kashmir. It rarely reaches a height of more than 50 ft. in its own home. The bark of the trunk is grey, slightly tinged with red and deeply divided into broad flat broken ridges, separating on the surface into small thin scales.

3. *Nyctanthus* Linn. There is one species of this genus, *N. arbor-tristis* Linn., in India. It is a small tree with drooping quadrangular branches and very rough, opposite leaves. The flowers, with a white salver-shaped corolla and an orange-coloured tube, are very fragrant, opening towards evening and dropping the next morning. It is often to be seen in Indian gardens, where it is cultivated for the delicious scent of its flowers. The dropped corollas are gathered and preserved for use in Hindu ceremonies. Apart from this use the corollas have been used since very early times to dye cotton.

4. *Syringa* Linn. *S. emodi* Wall. grows in the Himalayas between 7,000 and 10,000 ft. It is a large deciduous shrub or small tree with white ornamental flowers. The English Lilac, *S. vulgaris* Linn. is sometimes planted in hill-stations.

5. *Olea* Linn. *O. dioica* Roxb. is a moderate-sized to large tree which is found in the evergreen forests of the Western Ghats and also in Bengal and Assam. The bark is brown, very rough, soft and brittle; blaze buff. The leaves are, of course, opposite with a reddish petiole and midrib. When freshly cut the wood has a sweet scent and is called Rose Sandalwood in Bombay on that account. The wood is useful for carving and cabinet-making. Two small tree species are common in the Punjab.

They can be separated by the following key.

Leaves densely scaly beneath, not glandular in the nerve-axils ... *O. ferruginea*

Leaves glabrous, glandular in the nerve-axils

O. glandulifera

O. ferruginea Royle (*O. cuspidata* Wall.), the Indian Olive, is a small to medium-sized evergreen tree which is characteristic of the dry hills west of the Jhelum. The young shoots, petioles and leaves beneath are covered with minute reddish scales. The

bark is smooth when young but in old trees exfoliates in long narrow irregular strips. The wood is used locally.

O. glandulifera Wall. is a small evergreen tree with a grey bark exfoliating in brittle scales. It is found in the sub-Himalayan tract from the Indus eastwards and extends into the hills up to 6,000 ft. The wood is hard, reddish-grey in colour, and is durable.

O. europaea Linn. is the European Olive. The cultivation of this plant has been tried on several occasions in the north-western districts of India. In recent years some success has been obtained by grafting buds on to stocks of *Olea ferruginea*. *O. europaea* Linn. does not fruit properly in India.

6. *Linociera* Swartz. This is a genus of trees, or shrubs mostly evergreen, which are distributed all over India and Burma. The trees are inhabitants of the evergreen climax forests of this area and are recognized by their opposite leaves and large terminal panicles of 2-stamened flowers. The south Indian species, *L. malabarica* Wall., gives a very fine wood, like box-wood.

7. *Myxopyrum* Blume. The species of this genus found in India is *M. smilacifolium* Blume. It is a large glabrous twining climber with quadrangular branches. The reason for the specific name is that the leaves are strongly 3-5-nerved from the base and greatly resemble those of *Smilax*, a genus of liliaceous climbers and scramblers. In *Smilax*, however, the leaves are stipulate and alternate.

8. *Jasminum* Linn. A well-known genus of climbers and low bushes. Very common in India, where a number of them are cultivated in gardens.

47. APOCYNALES

Trees, shrubs, climbers or herbs ; flowers actinomorphic, hermaphrodite ; corona often present ; ovary bicarpellary ; carpels sometimes free ; stamens inserted in the tube, same number as corolla-lobes ; embryo straight ; endosperm present.

99. APOCYNACEAE 100. ASCLEPIADACEAE

99. APOCYNACEAE

Trees, shrubs or climbers, rarely perennial herbs (*Rauwolfia*), generally with milky juice. Leaves opposite or whorled, rarely alternate (*Plumeria*, *Rhazya*), simple, entire, exstipulate, or with rudimentary stipules. Inflorescence rarely of solitary flowers, usually of axillary or terminal corymbiform cymes, compound trichotomous cymes or terminal dichotomous panicles. Calyx free, divided nearly or quite to the base into five segments or sepals, often glandular inside; sepals generally imbricate in the

bud. Corolla hypogynous, gamopetalous, tubular, infundibuliform or hypocrateriform; throat often hairy or closed with a corona of scales, 5-lobed; lobes contorted, imbricate, rarely valvate. Stamens five, inserted inside the tube, alternate with the lobes of the corolla; filaments free; anthers often sagittate, free or connivent around the stigma, rarely adherent to the latter, 2-locular, opening by longitudinal slits; connective produced at the apex; pollen granular. Disk usually present, annular, cupular, or of separate glands. Ovary superior, 1-locular with two parietal placentas, or 2-locular with the placentas on the septum, or carpels two, free or connate only at the base. Style one, split at the base or entire; ovules two or more in each carpel. Fruit entire or indehiscent or of two separate ripe carpels, baccate, drupaceous or follicular. Seeds usually with endosperm; embryo straight.

A very easy family to spot. The milky latex, the twin-pods or follicles, and the overlapping lobes of the corolla, just like a propeller, are distinctive of the family.

Key to the more important woody genera of *Apocynaceae*

Anthers included, free from the stigma; the loculi rounded at the base:

Ovary of 2 wholly combined carpels, 1-2-locular; seeds without wing or coma ... 1. *Carissa*

Ovary of 2 distinct carpels, usually united by the style but sometimes at the base:

Leaves alternate; corolla large and showy, the lobes overlapping to the left:

Corolla funnel-shaped; fruit indehiscent:

Calyx glandular within; flowers yellow; leaves linear ... 2. *Thevetia*

Calyx not glandular within; flowers white; leaves oblanceolate, fleshy ... 3. *Cerbera*

Corolla salver-shaped; fruit of 2 dehiscent follicles; calyx not glandular within; flowers yellowish-white or -red ... 4. *Plumeria*

Leaves opposite or whorled; corolla salver-shaped:

Calyx not glandular within; fruit of 2-, 1- or many-seeded drupes or follicles:

Fruit indehiscent, drupaceous; seeds few, without wings or coma:

Corolla-lobes overlapping to the left:

Leaves usually whorled; erect shrubs; fruit mericarps more or less united, sessile ... 5. *Rauwolfia*

Leaves opposite; trees; fruit mericarps stalked ... 6. *Hunteria*

Corolla-lobes overlapping to the right;

trees or shrubs with opposite leaves;
fruit mericarps 1-2-seeded, free

7. *Kopsia*

Fruit dehiscent, of 2 slender many-seeded
follicles; corolla-lobes overlapping to the left

8. *Alstonia*

Calyx glandular within; fruit of 2 follicular
mericarps:

Follicles many-seeded, linear 9. *Holarrhena*

Follicles few-seeded, baccate, stout and coriaceous; seeds arillate, with coma; erect trees or shrubs:

Corolla-tube dilated at the base; lobes overlapping to the left; leaves with conspicuous horizontal impressed main-nerves

10. *Pagiantha* (*Rejoua*)

Corolla-tube slightly dilated near the top; lobes overlapping to the left or right; leaves with slender oblique main-nerves

11. *Ervatamia*

Anthers included or exserted, conniving in a cone round and adherent to the stigma; each loculus produced below as an empty spur; fruit of 2 follicular mericarps with comose seeds:

Anthers exserted:

Climbing shrubs; coma of the seeds terminal:

Filaments of the stamens long, spirally twisted

12. *Parsonsia*

Filaments of the stamens short, not spirally twisted

13. *Vallaris*

Erect trees or shrubs; coma of the seeds basal; corolla with a corona of scales ...

14. *Wrightia*

Anthers included:

Mouth of corolla with a ring of scales:

Erect shrubs with whorled leaves and pink flowers; corolla-lobes not tailed ...

15. *Nerium*

Spreading or climbing shrubs with opposite leaves; corolla-lobes tailed ...

16. *Strophanthus*

Mouth of corolla naked; leaves opposite; climbing shrubs:

Corolla very large, white; leaves very large:

Corolla campanulate or funnel-shaped

17. *Baumontia*

Corolla salver-shaped, lobes sharply twisted to the left ...

18. *Chonemorpha*

Corolla medium-sized; tube bearded within, behind the anthers; calyx divided nearly to the base

19. *Aganosma*

Corolla small, the lobes overlapping to the right:
 Follicles stout, large; the seeds long-beaked

20. *Anodendron*

Follicles very slender, narrow; tips of corolla-
 lobes deflected ... 21. *Ichnocarpus*

1. *Carissa* Linn. A genus of much-branched spinous erect or climbing shrubs. There are half a dozen species in India, none of which is of any great importance except *C. carandas* Linn., which, although wild in India, is extensively cultivated for its fruit. *C. opaca* Stapf (*C. spinarum* auct. non Linn.) is a gregarious evergreen thorny shrub in north-western India, where it often forms the underwood in *Pinus roxburghii* forests. It makes an excellent hedge.

2. *Thevetia* Linn. One species of this genus, *T. peruviana* K. Schum. (*T. nerifolia* Juss.), is a yellow-flowered shrub, which, originally introduced from Mexico and Brazil, is now so common in this country that it can be assumed to be naturalized. It grows easily from seed and is not touched by cattle or goats. All parts of the plant are poisonous, owing to the presence of a glucoside, closely allied to that of *Strophanthus*, in the latex. It is a useful ornamental plant because of its brightly coloured corolla, and owing to its immunity from browsing, it is invaluable as a hedge plant for rest-houses and avenues. This small tree is often called the Yellow Oleander.

3. *Cerbera* Linn. The only species of this genus in India, *C. manghas* Linn. (*C. odollam* Gaertn.), is a moderate-sized tree with bright-green fleshy leaves, large white flowers, and a large green fruit (turning rosy) with a fibrous pericarp. It inhabits the salt swamps of the coasts of India, Burma and the Andamans. The bark is grey and when blazed a copious milky juice flows out. This latex is avoided by tree-fellers as it is alleged to cause blindness if it falls on the eye. Actually it is quite harmless. It is easily recognized by its crowded alternate obovate leaves with many lateral nerves joined by an intra-marginal vein. The seeds are extremely poisonous on account of the presence in them of a glucoside, cerberin, which has a powerful effect upon the heart. The other parts of the tree are medicinal. *C. manghas* Linn. includes *C. odollam* Gaertn. and *C. lactaria* Buch.-Ham., but *C. manghas* and *C. odollam* are often considered to be distinct from one another. In *C. manghas* the 'eye' of the white flower is pink, and in the other species yellow. There are also other small differences which altogether do not justify the erection of two separate species.

4. *Plumeria* Linn. The species of this genus are natives of South America but are very widely cultivated in India for their ornamental flowers. *P. acuminata* Ait. (*P. acutifolia* Poir.), the Frangipanni, with cream flowers is, of course, well known but

P. rubra Linn., with red flowers, is also cultivated. The former is so often planted near places of worship that it is also known as the Temple or Pagoda flower. The fragrant flowers are often used for garlands.

5. *Rauwolfia* Linn. *R. serpentina* Benth. is a small glabrous herbaceous shrub with a wide distribution. It is easily recognized by its red calyx and pedicels and white flowers. This is a very important medicinal plant and many are the diseases it is supposed to cure.

6. *Hunteria* Roxb. *H. corymbosa* Roxb. is a small tree with yellow flowers and narrow linear-lanceolate shining leaves, with many nearly parallel main-nerves meeting in an intramarginal nerve. It is found in south India, in Tavoy, and extends into the Malay Peninsula. Easily recognized by the leaves, flowers and fruits, the latter being of two stalked globose berries, orange-red when ripe. The wood is hard, fine-grained and heavy, but owing to the difficulty of getting moderately long pieces it is not much used. In Malaya the latex is used for treating yaws. The bark contains a poisonous principle.

7. *Kopsia* Blume. *K. fruticosa* A. DC. is a pretty shrub with white or pink flowers with a crimson eye which is often cultivated for its beautiful flowers.

8. *Alstonia* R. Br. This is a genus of evergreen trees or shrubs of characteristic appearance. There are two common species in India.

A large tree with whorled branches; follicles 1-2 ft. long; seeds papillose ... *A. scholaris*

A shrub or small tree with opposite or whorled branches; follicles 3-5 in. long; seeds not papillose ... *A. venenata*

A. scholaris R. Br. is found scattered throughout the greater part of India. It gets its specific name from the fact that in bygone days the wood was used for making school-slates in Malaysia, the writing being rubbed off by *Delima* leaves (*Dilleniaceae*). The latex, leaves and bark are put to a number of medicinal uses. The wood is soft and white and is not durable but has been found suitable for match-splints.

A. venenata R. Br. is a shrub with long white flowers and stalked and beaked fusiform follicles. It is found in south India. Another species, *A. nerifolia* Don, is found in the eastern Himalayas. It is similar to the last-named species.

9. *Holarrhena* R. Br. The Indian species, *H. antidysenterica* Wall., is widely distributed throughout India in deciduous forests and open waste lands. The bark is brown in colour, scaly, with a creamy-yellow blaze exuding quantities of milky latex. The flowers are pure white and are borne in a terminal corymb. The bark is extensively used throughout India for the treatment of dysentery.

10. *Pagiantha* Mgf. (*Rejoua*). *P. dichotoma* Gaudich. (*R. dichotoma* Gamble; *Tabernaemontana dichotoma* Roxb.) is a small tree with stout woody resinous branches, with resinous exudations at the bases of the leaves, at the bifurcations of the inflorescence and on the buds. The bark when blazed exudes a copious milky latex. The flowers are large and white with a yellow tube.

11. *Ervalamia* Stapf. A genus of shrubs, formerly included in the genus *Tabernaemontana* Linn. The common garden-species *E. coronaria* (Willd.) Stapf (*Tabernaemontana coronaria* Willd.; *T. divaricata* R. Br. non aliorum) is extremely like, and is often mistaken for, *Coffea bengalensis*. Apart from morphological differences the former has a milky juice which the latter has not. In addition to this the capsules of the former are characteristic. They are greenish-yellow, inflated, and when dehiscent turn inside out, exposing the scarlet lining. The roots and leaves are used medicinally for various complaints.

12. *Parsonsia* R. Br. *P. spiralis* Wall. is a slender twining shrub found in most parts of India and Burma wherever evergreen climax forest is to be found. The yellowish- or purplish-green flowers are found at different times throughout the year. The fruit consists of two connate follicles, forming a grooved poniard-shaped compound follicle, which much resembles the fruit of an *Asclepiad*. The specific name was given to this plant on account of the twisted filaments.

13. *Vallaris* Burm. *V. solanacea* O. Ktze. (*V. heynei* Spreng., *V. dichotoma* Wall.) is a large straggling shrub with pretty bowl-shaped white flowers. It is possible that this plant may contain a poisonous glucoside allied to strophanthin.

14. *Wrightia* R. Br. A small genus of trees of which three species are found in India.

The following key can be used to separate them.

Corolla-tube as long as or longer than the sepals:

Leaves glabrous; coronal scales distinct, fimbriate;
follicles free or connate at tip, slender ... *W. tinctoria*

Leaves tomentose; coronal scales connate, short, obtuse;
follicles connate, stout ... *W. tomentosa*

Corolla-tube shorter than the sepals; follicles connate

W. coccinea

W. tinctoria R. Br. is a small deciduous tree of the Indian Peninsula extending northwards into the hotter and drier parts of central India. Bark pale, smooth; blaze green then white, milky. The wood is moderately hard and is used for local carved and turned articles. The leaves are used as wrappers for cigarettes in Bombay. It has, however, been shown that the seeds, roots and leaves of this species contain an indigo-yielding glucoside. The young leaves are bluish with reddish nerves.

W. tomentosa Roem. et Schult. is a small deciduous tree found throughout the greater part of India and also in Burma, ascending in the hills to an elevation of 4,000 ft. The bark is pale-grey, corky. The blaze is soft, with a thin chlorophyll layer outside, then nearly white or pale greenish-brown, exuding a yellowish-white latex. The seed and roots, but not the leaves, yield the same glucoside as the last-named species. This tree is easily recognized by its dark-green speckled pod-like fruits. The flowers are yellowish-white inside, greenish outside with a salmon-coloured corona, when first open, but as they fade they become a dull reddish-purple colour.

W. coccinea Sims. is a small tree found in the foot-hills tracts of the eastern Himalayas. Easily distinguished from the former two species by its handsome scarlet flowers. It has a pod-like fruit like that of *W. tomentosa*.

15. *Nerium* Linn. *N. indicum* Mill. (*N. odorum* Soland.), the Oleander, is a beautiful well-known shrub with usually erect (in the wild form often prostrate, ascending) rod-like branches and narrow leaves. This species is often cultivated in gardens but it is also wild in the north-western districts of India where it is found in the beds of hill-streams. All parts of the plant are said to be poisonous, the roots especially so. The poison consists of certain glucosides allied to digitalin, which act upon the heart, and small amounts are sufficient to cause death.

16. *Strophanthus* DC. A genus of woody climbers of which a few species are found in India. The following are the common Indian species.

Lobes of the corolla long and slender, up to 2 in. long

S. wallichii

Lobes of the corolla not more than 0.5 in. long

S. wightianus

S. wallichii A. DC. is a climbing shrub found in Assam in the Khasi Hills (Roxburgh also reports it from the Northern Circars). It has an ash-coloured bark and pale-yellow or pinkish flowers.

S. wightianus Wall. is a climbing shrub found on the west coast of Madras State.

Four species of *Strophanthus* are found in Burma and they can be separated by the following key. *S. wallichii* has been added as it may also be found in Burma.

Corolla-lobes tailed:

Tails more than 3 in. long

... *S. caudatus*

Tails less than 2 in. long:

Calyx-lobes 3 in. long, recurved

... *S. wallichii*

Calyx-lobes shorter, not recurved

... *S. scandens*

Corolla-lobes not tailed; lobes less than 0.25 in. long:

Leaves oblong-acute; secondary nerves of the leaves looped, conspicuous

... *S. singaporianus*

Leaves elliptic-acuminate; secondary nerves of the leaves
not looped, very inconspicuous ... *S. perakensis*

The synonymy of *Strophanthus* in Burma is in a chaotic state but the names below are in accord with the latest practice (1951).

<i>S. singaporianus</i> (Wall. ex G. Don)	
Gilg (<i>S. brevicaudatus</i> Wight):	Mergui
<i>S. caudatus</i> (Burm.) Kurz (<i>S. griffithii</i> Wight; <i>S. longicaudatus</i> Wight):	Tenasserim
<i>S. scandens</i> (Lour.) R. et S. (<i>S. caudatus</i> auct. pro parte):	Tenasserim
<i>S. perakensis</i> Scortechini ex King et Gamble:	Tenasserim

Several species of *Strophanthus* are known to contain the glucoside strophanthin. This drug has poisonous properties, a fact which was brought to light by the discovery that some African tribes used certain species of this genus to poison their arrows.¹ The drug can be used as an alternative to digitalin. The genus is easily recognized when in flower by the long tails to the corolla-lobes, and when in fruit, by the large and woody follicles which contain numbers of compressed fusiform seeds each narrowed to a feathery plumose point. The Malayan species, *S. dichotomus* DC., is often cultivated in gardens for its peculiar flowers.

17. *Beaumontia* Wall. This is a genus of two species only, *B. grandiflora* Wall., a climber of northern India, and *B. jerdoniana* Wight, a climber of the Western Ghats. The flowers of the former are bell-shaped and those of the latter funnel-shaped. They are both extremely handsome in flower, especially the former, and are often cultivated in gardens.²

18. *Chonemorpha* G. Don. This is also a genus of large climbing shrubs. The best-known and commonest species is *C. fragrans* Alston (*C. macrophylla* G. Don), which is found in the forests of the Western Ghats and also in the evergreen forests of Bengal, Assam and Burma. It is very easy to identify in the forest from its large, nearly orbicular, leaves which are fulvous-tomentose beneath. The flowers are large, white and fragrant. The latex gives an inferior rubber. Fibre can be obtained from the stem.

¹ The seeds of some of the African species also contain a substance known as sarmentogenin which can be used as a short-cut in the synthesis of cortisone, a compound which is specific in the treatment of rheumatoid arthritis.

² As the climber is in flower towards the end of March, the flowers invariably figure conspicuously in Dehra Dun in connexion with the festivities accompanying Convocation Day at the Forest Research Institute.

19. *Aganosma* G. Don. A genus of evergreen climbing shrubs. The following is a key to the more common species.

Ovary glabrous; cymes axillary ... *A. marginata*
 Ovary pubescent; cymes terminal:
 Cymes laxly corymbose; leaves with 3 pairs of main-nerves;
 seeds hollowed near the top ... *A. dichotoma*
 Cymes densely corymbose; leaves with 5-8 pairs of main-nerves; seeds slightly concave on one side *A. cymosa*

A. dichotoma K. Schum. (*A. caryophyllata* G. Don) is a large climber with white flowers and red calyx-lobes, found in south India and also in north-east India.

20. *Anodendron* A. DC. *A. paniculatum* A. DC. is a very large climber with large panicles of small yellow flowers. Merrill calls this plant *A. manubriatum* (Wall.) Merr. based on *Echites manubriata* Wall., a *nomen nudum*.

21. *Ichnocarpus* R. Br. One species, *I. frutescens* R. Br., an extensive evergreen twining shrub, is common in India. It is cultivated in gardens and the stems make strong ropes.

A large number of species are cultivated in gardens for their handsome flowers.

100. ASCLEPIADACEAE

Herbs or shrubs, often twining, almost always with milky juice. Leaves opposite, sometimes absent, very rarely alternate, entire, exstipulate, sometimes with stipular lines and intrapetiolar or interpetiolar glands. Flowers actinomorphic, hermaphrodite, arranged in axillary umbelliform cymes. Calyx-lobes five, imbricate. Corolla gamopetalous, 5-lobed; lobes valvate or overlapping to the right, throat often with a corolline corona. Stamens at the base of the corolla with filaments connate into a tube or free; tube often bearing dorsal processes known as the staminal corona. Anthers at the top of the column, connate or free, adnate to the stigmas. Pollen in one or two pollinia to each locus, united to a minute corpuscle between the anthers so that the outer pollinia of two adjacent anthers are so united. Carpels two, distinct, superior with ventral placentas. Ovules numerous in each carpel. Fruit of two, often widely divergent, carpels. Seeds often crowned with a coma of long silky hairs. Seeds with endosperm.

This family is closely allied to the *Apocynaceae* and differs mainly in the androecium which possesses a corona and pollinia. In species of *Wrightia* (*W. coccinea*), however, considered to be apocynaceous, there is what looks suspiciously like a corona, but the pollen is quite normal.

None of the species of this very large family are of importance to the forest officer apart from their use as minor forest-products. In times of stress, however, as for example in war, minor forest-

products assume an importance which is entirely absent in normal conditions. In the second World War the capture of Malaya by the Japanese in 1942 immediately affected world stocks of rubber. Administrations all over the world set about looking for other plants which would yield rubber. In India research was carried out at the Forest Research Institute with various species of the *Asclepiadaceae*, *Apocynaceae*, *Sapotaceae*, etc. One species of *Cryptostegia* showed a very high proportion of caoutchouc to resins and was widely grown for the purpose of helping to supply some of the much needed rubber.

Apart from this, however, the structure of the flowers is so extraordinary, in the diversity of the corona at the apex of the staminal column, that this family well repays close study. The pollen occurs in compact masses, called pollinia, and the pollinia of two adjacent anthers are attached to one another through the corpuscle. The pollinia are the result of the agglutinated pollen and in the orchids a very similar condition is found.

A very tenacious fibre is yielded by certain species of *Marsdenia*, a genus the leaves of which turn bluish on drying.

48. RUBIALES

Trees, shrubs or herbs ; flowers actinomorphic, hermaphrodite ; ovary inferior ; stamens epipetalous, alternate with the corolla-lobes ; embryo straight ; endosperm usually present.

101. RUBIACEAE 102. CAPRIFOLIACEAE

101. RUBIACEAE

Trees, shrubs or herbs. Leaves opposite or whorled, simple, usually entire, stipulate; stipules often interpetiolar or intra-petiolar, free or connate, sometimes leafy and indistinguishable from leaves. Inflorescence of solitary flowers, or flowers paniced or capitate. Calyx adnate to the ovary, truncate, lobed or toothed; lobes or teeth usually 4-5, one occasionally developed into a leaf. Petals gamopetalous, 4-5, contorted, imbricate or valvate. Stamens as many as the corolla-lobes and alternate with them, sometimes sessile; filaments usually short; anthers 2-locular, introrse, opening by longitudinal slits. Disk present, epigynous, sometimes fleshy. Ovary inferior, 2- or more-locular; ovules one or more in each loculus, attached to axile placentas. Fruit a capsule, berry or drupe. Seeds with endosperm; embryo straight or curved.

Rubiaceae is an exceedingly large family and many are the herbs, shrubs and climbers found in the forests of India at all altitudes where forests exist. Tree species are rather fewer in number and are mostly found in the plains districts.

The family is a popular one with forester and student because of the ease with which it can be recognized in the field. Any plant with opposite entire leaves and interpetiolar stipules can be referred tentatively to *Rubiaceae*. If it can be ascertained from the fruit or flower that the ovary is inferior, then the plant can be referred to *Rubiaceae* with certainty.¹

All the woody species of *Rubiaceae* cannot, because of their number, be treated in this book, but some genera of shrubs, small trees and climbers can be referred to their genera by certain characteristics. *Uncaria*, for example, a genus of climbers, has the flowers in heads, and the sterile branches transformed into hooks. In *Paederia*, a creeper, and in *Hamiltonia* and *Serissa*, ornamental shrubs, the leaves and flowers are extremely foetid when crushed. In *Lasianthus*, a genus of shrubs, the berries are a metallic-blue. *Mussaenda*, which comprises several climbing shrubs, a few of which are cultivated in gardens, has one calyx-lobe converted into a leaf-like structure which is usually white but may be yellow or red. *Hymenopogon*, an epiphyte of the hill-forests, also has a foliaceous calyx-lobe. In this case the skeleton of the calyx-lobe remains after the fruit has formed, and, when agitated by the wind, helps the capsule to pour out its seed. *Morinda*, a genus of shrubs, is easily recognized when in fruit. Here a compound fruit is formed, composed of the purplish-white coalescing drupes. *Pavetta*, *Ixora* and *Stylocoryne* are rather similar in appearance, possessing crowded flowers with long tubular corollas. In the former two the corollas are 4-lobed and in the latter 5-lobed. *Pavetta* differs from *Ixora* by its entire style. *Rubia* and *Galium* are genera of herbs with whorled leaves. The former has a 5-merous and the latter a 4-merous corolla. *Rubia cordifolia* Linn. is the well-known twiner, from which a red dye is obtained.

One of the more remarkable plants belonging to the family is *Hydnophytum formicarium* Jack. This is a small epiphytic shrub which is an inhabitant of the mangrove swamps and is frequently found growing upon *Heritiera littoralis*. The stems have very swollen bases and inside them will be found the complicated system of corridors and chambers, which make up the home of the tree-ants which inhabit them. A number of woody epiphytic species (e.g. members of the *Vacciniaceae*) develop swollen bases to the stems and it is obviously in these swellings that reserve supplies of food are stored. It would be an interesting line of research to find out whether swellings are produced naturally on the roots of *Hydnophytum* or whether these swellings are the result of the activity of the ants.

¹ See *Rhizophoraceae*.

A good many of the species of *Rubiaceae* are medicinal. The genus *Cinchona* is among the first that spring to the mind. Several species have long been cultivated in India for their anti-malarial drugs. *Cephaelis ipecacuanha* Rich. is an exotic which has been cultivated with some success in India for the sake of the drug emetine, which is a specific for amoebic dysentery. Several other species yield drugs used in Indian medicine.

The family *Rubiaceae* is very similar in appearance to *Caprifoliaceae*, the absence of stipules in the latter being the main distinguishing character. *Sambucus*, a genus of the latter family, which does possess stipules, has got compound leaves, so that there cannot be any confusion between the families.

The following is a key to the genera of *Rubiaceae* which reach tree size.

Flowers collected into dense globose heads:

Calyx-tubes fused into a fleshy mass ... 1. *Nauclea*

Calyx-tubes not fused into a fleshy mass:

Corolla-lobes imbricate; flowers ebracteolate:

Stigma fusiform; seeds not winged 2. *Anthocephalus*

Stigma globose; seeds winged ... 3. *Neonauclea*

Corolla-lobes valvate; flowers bracteolate:

Stigma clavate; calyx-lobes 5 ... 4. *Adina*

Stigma mitriform; calyx-tube truncate 5. *Mitragyna*

Flowers not in globose heads:

Fruit capsular ... 6. *Hymenodictyon*

Fruit baccate:

Corolla-lobes imbricate ... 7. *Hamelia*

Corolla-lobes twisted:

Ovary 2-locular ... 8. *Randia*

Ovary 1-locular ... 9. *Gardenia*

Corolla-lobes valvate ... 10. *Canthium*

1. *Nauclea* Linn. There are two species of this genus in India. *N. missionis* Wight et Arn. (*Sarcocephalus missionis* Hav.), an evergreen tree from Madras State, and *N. orientalis* Linn. (*Sarcocephalus cordatus* Miq.), a large deciduous tree from Ceylon and Burma. The wood is soft but nothing much is known of it.

2. *Anthocephalus* A. Rich. The only species in India, *A. cadamba* Miq. (*A. indica* A. Rich.), is a large deciduous tree with cylindrical stem and horizontal branches and large shining leaves with prominent veins. The bark is grey and smooth in the young tree, becoming darker and longitudinally fissured in older trees, exfoliating in small rectangular plates, with a yellowish-brown blaze. The tree is common in moist deciduous and evergreen forest and has a wide distribution in India. The wood is soft, yellowish-white and even-grained and is valuable

as a source of matchwood, plywood and paper. It is known in the trade as Kadam.

3. *Neonauclea* Merr. is a small genus of about seven species, of which the majority are found in Burma and the Andamans. One species is found in the Western Ghats. All of them will be found under *Nauclea* in Brandis, *Indian Trees*, but have been transferred to Merrill's new genus *Neonauclea*. None of them is of any importance.

4. *Adina* Salisb. Of the three species in India, only *A. cordifolia* Hook. f. is of any importance to the forest officer. It is a large deciduous tree with cordate leaves. The connate stipules are large and foliaceous, protecting the terminal leaf-bud. This tree reaches very large proportions and girths up to 17 ft. have been recorded and heights up to 138 ft. The bark is grey, exfoliating in patches which leave indentations. The blaze is pink. The habitat of this tree is in the drier parts of India and Burma. The wood is yellow and is used for a variety of purposes. The trade name is Haldu.

5. *Mitragyna* Korth. (*Stephegyne* Korth.) is a small genus of deciduous trees. Most of the species of this genus possess medicinal properties.

There are three species found in India and Burma which can be separated by the following key.

Calyx-limb short; flowers yellow or greenish-white:

Flowering heads solitary or in cymes of 3 heads, the terminal sessile, the 2 lateral on peduncles 2 in. long.

M. parvifolia

Flowering heads in ample terminal trichotomous cymes

M. rotundifolia

Calyx-limb elongate; flowers purple ...

M. tubulosa

M. parvifolia Korth. (*Stephegyne parvifolia* Korth.) is a large deciduous tree with a fluted or buttressed base. The bark is grey and smooth, exfoliating in scales which leave shallow depressions. It is found throughout the greater part of India and Burma in deciduous forests. Wood of local use only.

M. rotundifolia O. Ktze. (*Stephegyne diversifolia* Hook. f.) is a moderate-sized deciduous tree found in the Andamans, Chittagong and Burma. The bark is light-grey with a light-brown dry mealy-fibrous blaze.

M. tubulosa Har. (*Stephegyne tubulosa* Hook. f.) is a small tree with a restricted distribution in Cochin and Travancore. It is easily distinguished from its cogeners by the possession of purple flowers.

6. *Hymenodictyon* Wall. A small genus of trees, three being found in India and Burma, which are exceedingly easy to spot in the forest on account of the large reddish-brown foliaceous petiolate bracts which remain long on the tree.

Flowers pedicelled	... <i>H. excelsum</i>
Flowers sessile:	
Flowers in drooping simple spikes	... <i>H. flaccidum</i>
Flowers in erect spicate panicles	... <i>H. obovatum</i>

H. excelsum Wall. is a large deciduous tree distributed throughout the greater part of India and Burma in mixed deciduous forest where the soil is deep and porous. The bark is greyish-brown, thick, soft, corky and furrowed on the stems of old trees, smooth on young stems. This tree is leafless for most of the cold weather and the red persistent bracts are most conspicuous. Wood soft, white, very suitable for match-splints.

H. flaccidum Wall. is a rather rare tree found in the hills of the eastern Himalayas and in the Khasi Hills. It is often epiphytic.

H. obovatum Wall. is a large deciduous tree found in the Western Ghats of Bombay and Madras States. The bark is thick, soft, grey in colour, exfoliating in irregularly shaped scales; inner bark very bitter. This tree is deciduous for most of the cold weather and is easily identified from the presence of the long-petioled foliaceous bracts. The bark contains a bitter principle which is used by the local inhabitants as a substitute for quinine. As the genus belongs to the *Cinchoneae*, it is possible that the substance may be antimalarial. The wood is similar to that of *H. excelsum*.

7. *Hamelia* Jacq. *H. patens* Jacq., a native of America, is commonly grown as an ornamental tree. Its main interest for the botanist lies in the fact that the flowers are arranged in a cymose inflorescence technically known as bostryx.

8. *Randia* Linn. This genus is rather an extensive one and there are about fifteen Indian and Burmese species. *R. dumetorum* Lam. is a small deciduous tree with spiny branches. It has a very wide distribution in India and Burma and outside these countries it extends into Africa and Java. It is interesting for the fact that the ripe fruit can be eaten after cooking, but when unripe it is used to poison fish. The flowers are often large and are pure white at first, afterwards turning yellowish. The flowers of this genus can be recognized from the subsessile anthers lying flush with the corolla-limb.

9. *Gardenia* Linn. This genus of shrubs and small trees is closely allied to *Randia* but here the stamens are not exserted; moreover, the ovary is 2-locular as against 1-locular.

10. *Canthium* Lamk. (*Plectronia* Linn.). This genus contains twelve or thirteen species in India and Burma. The commonest species is *C. dicoccum* Merrill (*Plectronia didyma* Kurz), found in the Western Ghats and extending eastwards into Burma. It is a small evergreen tree with more or less quadrangular branches. The wood is close-grained and is very similar to box-wood.

102. CAPRIFOLIACEAE

Usually shrubs, often climbers with conspicuous pith (*Sambucus*). Leaves opposite, simple or pinnate, exstipulate or stipules very small. Flowers hermaphrodite, actinomorphic or zygomorphic, usually arranged in cymose panicles, sometimes in pairs on axillary peduncles. Calyx adnate to the ovary, 5-toothed or lobed. Corolla epigynous, gamopetalous, sometimes 2-lipped, 5-lobed, lobes imbricate. Stamens five, inserted in the corolla-tube, alternate with the lobes; anthers free, 2-locular, opening lengthwise. Ovary inferior, 2-5-locular. Ovules one or more to each loculus, pendulous or axile. Fruit a fleshy berry. Seeds with copious endosperm and small embryo.

A favourite family with examiners, who expect students to confound it with *Rubiaceae* (and they often do) which it resembles in some respects. No student should ever fall into the trap if he remembers that the stipules are interpetiolar in *Rubiaceae*, very small or missing in *Caprifoliaceae*.

Viburnum Linn. has a number of species which are common in the hills and are recognized by their rather coarse leaves, white corolla and bright-red or black fruits. One species, *V. colebrookianum* Wall., with cream-coloured flowers, is common in the plains of Bengal and Assam and in the adjoining foot-hills.

49. BIGNONIALES

Trees; flowers zygomorphic, hermaphrodite; corolla 5-lobed; ovary superior, 2-locular; stamens four or two, perfect, alternate with the corolla-lobes; embryo straight; endosperm absent.

103. BIGNONIACEAE

Trees, shrubs or woody climbers. Leaves opposite, most often compound, digitate or pinnate, sometimes terminating in a tendril, exstipulate. Inflorescence of racemes, panicles or corymbs. Flowers hermaphrodite, zygomorphic. Calyx gamosepalous, campanulate, truncate or 5-toothed, or 2-labiate, sometimes spathaceous. Corolla gamopetalous, hypogynous, with five lobes, of which the upper two often form one lip and the other three a lower; lobes imbricate. Stamens five, inserted on the corolla-tube, rarely all fertile, usually four, sometimes two (*Catalpa*), didynamous; anthers 2-locular, connivent in pairs, opening by longitudinal slits; fifth stamen rudimentary, often absent altogether. Disk present, glandular. Ovary superior, 2-locular, or 1-locular; placentas two on the septum in each loculus in the 2-locular ovary, two parietal in the 1-locular ovary; ovules many; style terminal, with two lamellate stigmas. Fruit capsular or fleshy and indehiscent. Seeds often winged, without endosperm; embryo straight.

Key to the genera of *Bignoniaceae*

Perfect stamens 5; a tree with 2-3-pinnate opposite leaves and very large flat capsules ... 1. *Oroxylum*

Perfect stamens 4; trees:

Anther-loculi 1 perfect, 1 reduced to a small hook; tall tree with white tubular flowers ... 2. *Millingtonia*

Anther-loculi 2, both perfect:

Foliage like that of an *Acacia* or *Mimosa*; flowers mauve or bluish-mauve ... 3. *Jacaranda*

Foliage not as above:

Leaves simple ... 4. *Tecomella*

Leaves compound:

Fruit gourd-like ... 5. *Kigelia*

Fruit not gourd-like:

Capsule not winged, cylindric, flattened or subquadrangular:

Calyx spathaceous, split on one side; corolla-tube slender; lobes spreading, crisped on the margins:

Flowers white ... 6. *Dolichandrone*

Flowers yellow ... 7. *Markhamia*

Calyx not spathaceous; corolla-tube ventricose:

Capsule with a flat or angular septum

8. *Heterophragma*

Capsule with a cylindric or spongy septum:

Septum prominently pitted; seeds trigonous ... 9. *Stereospermum*

Septum faintly pitted; seeds flat

10. *Radermachera*

Capsule winged on both margins; septum flat; large tree with large pinnate leaves.

11. *Pajanelia*

1. *Oroxylum* Vent. The Indian species, *O. indicum* Vent., is a conspicuous but ungainly tree which can at once be recognized by its 2-3-pinnate leaves and long (up to 3 ft.) flat capsules. The bark is soft, light brownish-grey with a yellowish-green blaze. The tree is found throughout the greater part of India in deciduous forests but is rare west of the Jumna. The leaves turn coppery-brown before falling and the tree is very conspicuous when leafless from the very large leaf scars and gigantic pods. The wood is useless, but tanning and dyeing can be carried out with the pods and bark. The seeds and bark are medicinal. This tree bears a superficial resemblance to *Heteropanax fragrans* Seem.; the latter has, however, alternate leaves. The flowers, purple in colour, open at night and emit an odour which

is better avoided. It is believed that the flowers are pollinated by bats.

2. *Millingtonia* Linn. f. *M. hortensis* Linn. f. is a tall, handsome tree with a corky dark yellowish-grey bark. It is said to be indigenous in Burma but is widely cultivated in India as an ornamental tree. It grows very rapidly and straight and produces its numerous fragrant white flowers at the beginning of the cold weather. It is liable to be thrown by the wind. The wood is white and soft.

3. *Jacaranda* Juss. *J. mimosifolia* D. Don¹ is a native of Brazil but is rapidly becoming a common tree in India on account of the handsome mauve-blue flowers and mimosa-like foliage. The fruit is a flat orbicular woody capsule, not at all like a bignoniaceous fruit.

4. *Tecomella* Seem. *T. undulata* Seem. (*Tecoma undulata* G. Don) is a deciduous shrub or small tree with, on old stems, a dark-grey or reddish-brown bark. It is found in the drier parts of north-western India from Delhi to the Indus and on the outer Himalayas up to 4,000 ft., but is extensively cultivated in north Indian gardens.

5. *Kigelia* DC. *K. ethiopica* Dcne. (*K. pinnata* DC.) is an African species very extensively cultivated in India as an ornamental and as a road-side tree. The large gourd-like fruits are very distinctive and at once betray the identity of the tree. The dull liver-coloured flowers are borne in long (up to 6 ft. long) drooping racemes from the old wood and are extremely foul-smelling. It is generally known by the trivial name of Sausage tree.

6. *Dolichandrone* Fenzl. There are four species of this genus in India and the following key separates them.

Corolla 4-7 in. long	... <i>D. spathacea</i>
Corolla under 3 in. long:	
Corolla more than 1.5 in. long:	
Glabrous	... <i>D. atrovirens</i>
Pubescent	... <i>D. arcuata</i>
Corolla less than 1.5 in. long	... <i>D. falcata</i>

D. spathacea K. Schum. (*D. rheedii* Seem.) is a moderate-sized deciduous tree with beautiful white flowers which open at night and then fall off. This tree is found in the coastal swamps of India and Burma. Parkinson says that in the Andamans it is associated with *Barringtonia racemosa*. The young flowers and fruits are eaten as a vegetable by Burmans. The tree is sometimes planted for ornament but the wood is light and not durable.

D. atrovirens Sprague (*D. crispa* Seem.) is a moderate-sized

¹ This name is preferable to *J. ovalifolia* R. Br.

tree with pretty white flowers common in the deciduous forest of the Deccan and Carnatic. The wood is yellowish-brown in colour and useful.

D. arcuata C. B. Cl. is a moderate-sized tree with a brown bark peeling off in flakes. It is an inhabitant of the Deccan.

D. falcata Seem. is a small deciduous tree with a bluish-grey bark exfoliating in scales, common in the dry deciduous forests of central India, extending to most of the forests of Madras and Bombay States. The wood is mottled-grey, hard and seasons well. It is used locally.

7. *Markhamia* Seem. *M. stipulata* Seem. (*Dolichandrone stipulata* Wall.) is a small to moderate-sized deciduous tree found in the dry mixed deciduous forests of Burma. The corolla is foetid but is said to be eaten. The wood is close-grained, orange-red and beautifully mottled. *M. platycalyx* Sprague is a native of Uganda and has been introduced into India. It reaches a height of about 50 ft. and has a grey-brown bark exfoliating in irregular strips and patches. The blaze is white. The flowers are very handsome, being yellow, striped and spotted with red. The wood is said to be valuable and moderately resistant to termites.

8. *Heterophragma* DC. There are two common species of this genus in India.

Flowers white to pink; leaflets 3-4 pairs; capsule not ribbed

H. quadriloculare

Flowers yellow; leaflets 2-3 pairs; capsule ribbed

H. adenophyllum

H. quadriloculare K. Schum. (*H. roxburghii* DC.) is a large tree with fragrant white or rose-coloured flowers and densely tomentose calyx. The bark is grey and scaly. The tree is found in Madhya Pradesh extending southwards and south-westwards in Bombay and Madras States where it occurs scattered in deciduous forests. The wood is moderately hard but is not much used.

H. adenophyllum Seem., now known as *Haplophragma adenophyllum* (Wall.) Dop, is a large tree found in the evergreen and deciduous forests of Assam, Burma and the Andamans. The bark is whitish with shallow fissures; blaze fibrous, cream, with darker streaks deepening in colour. According to Parkinson the wood is orange-yellow with darker streaks, is moderately hard and is said not to warp or split. In spite of this, however, the timber is not used.

Paul Dop separates¹ *Heterophragma adenophyllum* Seem.

¹ See article on the *Bignoniaceae* in the *Bulletin de la Société Botanique de France*, vol. 72, 1926, pp. 887-91.

from the genus *Heterophragma* and places it in the new genus *Haplophragma* P. Dop, on the ground that the structure of the follicle is different. In *Haplophragma* the follicle is 2-chambered, in *Heterophragma* 4-chambered by the intrusion of a false septum. Dop gives a key to the species of the section *Tecomeae*, distinguished by a wingless pod and opposite imparipinnate compound leaves, which is reproduced here as it will be of use in running down genera of this difficult section.

Septum cylindric, or a little compressed, spongy:

Seeds trigonous in deep depressions in the septum

Stereospermum

Seeds flattened, applied to the septum but not in deep depressions ...

Radermachera

Septum flattened or quadrangular in section by the development of a false septum:

Septum flat; no false septum; fruit 2-locular:

Calyx spathaceous ...

Spathodea

Calyx not spathaceous ...

Haplophragma

Septum with a false septum; fruit 4-locular:

Calyx spathaceous:

Seeds with a corky wing; corolla-tube long, slender

Dolichandrone

Seeds with a hyaline wing; corolla-tube short, inflated ...

Markhamia

Calyx not spathaceous ...

Heterophragma

9. *Stereospermum* Cham. is a genus of deciduous trees with three species in India.

Filaments of the stamens with a tuft of woolly hairs at the base; capsule 4-angled ...

S. personatum

Filaments of the stamens without a tuft of woolly hairs at the base:

Leaflets very shortly petioluled; capsule rather stout, terete, usually straight ...

S. suaveolens

Leaflets not very shortly petioluled; capsule slender, terete, often curved ...

S. angustifolium

S. personatum Chatt. (*S. tetragonum* DC. *S. chelonoides* C. B. Cl. non A. DC.) is a large deciduous tree with yellow flowers veined with red and capsules up to 2 ft. long. The bark is grey to brown in colour, rather thick with characteristic shallow horizontal depressions. Common in India where mixed deciduous forests are found. It is one of the trees which are fire-resistant. The wood is hard, grey, not differentiated as heartwood and sap-wood, fairly durable, elastic and easy to work.

S. suaveolens DC. is a large deciduous tree with dull-crimson

flowers and capsules up to 18 in. long. The bark is grey, exfoliating in large flat scales; blaze pale-yellow, distinctly zoned into hard and soft layers. It is common in mixed deciduous forests in India and is an important accessory species particularly in sal forest. The wood is known in the trade as Padri wood.

S. angustifolium Haines is a small tree with very nodose branchlets and leaves clustered at their ends, found in Orissa and Madras State.

Another three species are found in Burma.

10. *Radermachera* Zoll. et Mor. has two species in India and Burma.

Capsules up to 3 ft. long; corymbs pubescent *R. xylocarpa*
Capsules up to 18 in. long; panicles glabrous *R. gigantea*

R. xylocarpa K. Schum. (*Stereospermum xylocarpum* Benth.) is a large deciduous tree with large bipinnate leaves and fragrant white or pinkish flowers in corymbs. The bark is light-grey in colour, rather thick, smooth and flaky; blaze brown and cream, darkening on exposure. It is found in the deciduous forests of Madhya Pradesh, Bombay and Madras States and in Travancore. The wood is hard, tough and elastic with a small orange-brown heartwood.

R. gigantea Miq. (*Stereospermum hyposticum* Miq.) is a tree which appears in Kurz, *Forest Flora of Burma*, under the name *R. amoena* Scem. It is a small tree, apparently confined to Burma but is sometimes planted in gardens.

11. *Pajanelia* DC. *P. longifolia* K. Schum. (*P. rheedii* Wight) is a large tree with a wide distribution in India, from Assam and Burma to the west coast, being absent from the hotter and drier parts. The bark is thick, dark-brown, rough and fissured; blaze white, streaked with brown. The flowers are dull greenish-red in colour with yellowish lobes, crisped on the margins, and have a soapy smell. The tree is easily recognized, when in fruit, from its capsule, which is winged and about 2 ft. long. It somewhat resembles that of *Oroxylum indicum* Vent. Parkinson says the wood smells like teak when freshly cut and it is apparently resistant to the attacks of white ants (termites).

A good many species of *Bignoniaceae* are cultivated in gardens and as road-side trees for their beautiful flowers or stately appearance. Reference has already been made to the genera *Tecomella*, *Kigelia* and *Millingtonia*. In addition to these, other introductions include *Spathodea campanulata* Beauv., with flame-coloured flowers, from Africa; *Parmentiera cereifera* Seem., the Candle tree from Panama; and *Crescentia cujete* Linn., the Calabash tree.

The genus *Catalpa* Juss. is often met with in the hills.

The three common species can be separated by the following key (after Parker).

Flowers large, over 1 in. long, ground-colour white; leaves not lobed:

Flowers in few-flowered panicles; calyx villous

C. speciosa

Flowers in many-flowered panicles; calyx glabrous

C. bignonioides

Flowers small, about 0.7 in. long, ground-colour yellowish; leaves somewhat 3-lobed ... *C. kaempferi*

C. speciosa Warden is a native of the U.S.A.

C. bignonioides Walt. is from the southern U.S.A.

C. kaempferi Sieb. et Zucc. is indigenous to Japan.

Apart from these tree species many flowering bigoniaceous climbers have been introduced into India, and are cultivated everywhere in gardens.

50. VERBENALES

Shrubs or herbs; flowers hermaphrodite, zygomorphic; corolla gamopetalous, 4-5-lobed; ovary superior, 2-8-locular; stamens on the corolla, four or two; embryo straight; endosperm scanty or absent.

104. VERBENACEAE

Herbaceous or woody plants often with quadrangular branches. Leaves opposite or whorled, rarely alternate, simple or compound, exstipulate. Inflorescence of capitate cymes, or centripetal spikes or compound corymbiform, pyramidal or thyrsoid cymes. Flowers zygomorphic, hermaphrodite, 4-5-merous. Calyx gamosepalous, persistent, often enlarged in the fruit, 4-5-toothed or lobed. Corolla gamopetalous, hypogynous, 4-5-lobed; lobes imbricate in the bud. Stamens inserted on the corolla-tube, usually four, didynamous, sometimes two, very rarely five (*Tectona*); anthers 2-locular; loculi sometimes diverging, opening by longitudinal slits. Ovary superior, 2-8-locular, often 4-locular; style terminal, simple; ovules solitary or two in each loculus. Fruit a drupe or berry. Seeds without endosperm; embryo straight.

Key to the genera of *Verbenaceae*

Inflorescence spicate, centripetal, the lowest flowers opening first:

Calyx truncate or obscurely lobed; fruit drupaceous, succulent ... 1. *Lantana*

Calyx 2-4-lobed; fruit dry, hard ... 2. *Lippia*

Inflorescence cymose, centrifugal (end flower opening first):

Cymes paniculate; drupes fleshy:

Leaves simple:

Corolla regular; stamens equal:

Flowers 4-merous; drupes with 4 pyrenes

3. *Callicarpa*

Flowers 4-6-merous; drupe with 4-locular endocarp

4. *Tectona*

Corolla 2-lipped; stamens 4, didynamous:

Drupe with 1 pyrene, 4-locular:

Flowers small ...

5. *Premna*

Flowers large ...

6. *Gmelina*

Drupe with 4 pyrenes, 1-3 often suppressed

7. *Clerodendrum*

Leaves digitate ...

8. *Vitex*

Cymes capitate; bracts of the heads forming an involucre:

Bracts 3-5, blue or mauve:

Bracts blue ...

9. *Petrea*

Bracts mauve or pink ...

10. *Congea*

Bracts 6, not blue or mauve:

Corolla 6-16-merous; stamens long, exserted

11. *Symphorema*

Corolla 5-6-merous; stamens included or shortly exserted ...

12. *Sphenodesma*

Inflorescence capitate or shortly spicate; calyx 5-partite; lobes concave, imbricate; fruit capsular ...

13. *Avicennia*

1. *Lantana* Linn. There are two species of this genus in India both of which are of some importance.

Erect shrubs; stems not prickly ... *L. trifolia*

Straggling or climbing shrubs; stems prickly ... *L. aculeata*

L. trifolia Linn. (*L. indica* Roxb.) is a pretty aromatic shrub believed to have been introduced from tropical America into Asia, more than a hundred years ago. The flowers are lilac or reddish, rarely white or bright-red and are odourless. Often gregarious in places where it is not wanted; for example in regeneration areas of *Pinus insularis* Engl.

L. aculeata Linn. (*L. camara* Linn.) is a very serious pest in parts of India, notably in Bombay and Madras States where it has invaded plantation areas of teak, making it very difficult for mazdoors to penetrate and thin the plantations, besides being a constant fire hazard. The leaves in this plant also smell strongly, somewhat suggesting sage. It is considered to be a native of Central America and in certain parts of India is valued as a hedge. The flowers are pretty, being usually orange, varying to white or purple, and smelling strongly of black-currents. Many ways of eradicating the pest have been

tried but, according to Burkill, the most successful seems to be to saw off the stems close to the ground and paint the exposed wood with sodium arsenate, which is absorbed into and kills the root.

2. *Lippia* Linn. This shrubby genus is of no importance to forestry. Its interest lies mainly in the resemblance one of its species bears to *Lantana trifolia* Linn. There are three species found in India.

Lemon scented shrub	...	<i>L. citriodora</i>
Aromatic but not lemon-scented:		
Shrub	...	<i>L. geminata</i>
Creeping herb	...	<i>L. nodiflora</i>

L. citriodora Kunth is the lemon-scented Verbena of horticulturists. *L. nodiflora* Rich. is a creeping herb of wet places. *L. geminata* H. B. K. is a gregarious shrub with a sage-like smell. The flowers are scented, pink, and are borne in capitate spikes. The calyx, corolla and drupes are quite different from those of *Lantana*.

3. *Callicarpa* Linn. A genus of trees and shrubs common in India and Burma.

The following is a key to the shrub or small tree species.

Petiole over 1 in. long; leaves entire:

Calyx truncate:

Calyx hairy at flowering time	...	<i>C. tomentosa</i>
Calyx glabrous at flowering time	...	<i>C. vestita</i>
Calyx shortly 4-lobed	...	<i>C. lanata</i>
Petiole under 1 in. long; leaves serrate	...	<i>C. macrophylla</i>

C. tomentosa Murr. (*C. arborea* Roxb.) is a small or moderate-sized tree with a light or sand-coloured bark; blaze soft, white, with yellowish streaks, becoming darker in colour on exposure. The tree is widespread in India and Burma, except in the Punjab and drier parts. In Assam and Burma it ascends in the hills to 5,000 ft. and often takes possession of abandoned fields in the hills. It is one of those trees which can resist the effects of fire and it is a familiar sight in open burnt grassland. The wood is useless. The bark is often chewed with betel by the Assam hill-tribes.

The same remarks apply to *C. vestita* Wall., found in Sikkim, and the Khasi Hills. The other two species, *C. lanata* Linn. and *C. macrophylla* Vahl, are hardly more than shrubs.

4. *Tectona* Linn. f. This genus has two species in India and Burma.

Young branchlets 4-angled; fruiting calyx inflated

T. grandis

Young branchlets 6-8-angled; fruiting calyx not inflated

T. hamiltoniana

T. grandis Linn. f. is a large deciduous tree, indigenous throughout the greater part of the Indian Peninsula and Burma. According to Troup this tree flourishes best in a fairly moist, warm, tropical climate but it is actually found in very dry areas. Nobody is likely to 'slip up' over the teak-tree but the furrowed branchlets with a quadrangular pith and the very large leaves, with red glandular dots beneath, when young, black when old, and the bladder-like fruits are quite sufficient to distinguish it from any other. If the young leaves are rubbed between the hands, the palms will be stained a deep red. The timber is world-famous.

T. hamiltoniana Wall. is a much smaller tree in all respects than *T. grandis* and is found growing in the dry zones of Burma. It has a useful timber which is little used.

5. *Premna* Linn. is a genus of trees and climbing shrubs. It contains one very interesting species, *P. herbacea* Roxb.; interesting because in contrast to all the other species in the genus it is only a few inches high and comes up after the annual fires in the savannah and presses its leaves flat on the soil. It is supposed to have become dwarfed by repeated periodic fires. Most species have a rather pale bark which, in certain species, e.g. *P. bengalensis*, is soft and sweet and can be eaten.

6. *Gmelina* Linn. has three Indian and Burmese species, one of which is an introduced shrub.

A thorny sprawling shrub; bracts coloured, conspicuous

G. philippinensis

Trees or shrubs; bracts inconspicuous:

Tree

... *G. arborea*

Shrub, often spiny, or climbing

... *G. asiatica*

G. philippinensis Cham. (*G. hystrix* Schub.) is a thorny sprawling shrub with large yellow flowers and conspicuous large coloured bracts, sometimes found in gardens.

G. arborea Roxb. is a moderate-sized to large deciduous tree found scattered throughout India, mainly in deciduous forests. The under-surface of the leaves shows one to several large glands between the primary nerves. The bark is light-grey, exfoliating in irregularly shaped flakes leaving lighter-coloured patches beneath; blaze thick, with a chlorophyll layer just under the epidermis, then pale-yellow, white inside. The yellow flowers are produced in profusion when the tree is leafless, and this tree is valued *inter alia* as an ornamental tree. The wood is yellowish or whitish, even-grained, soft and easy to work. It is esteemed for a variety of uses, especially for drums, as it does not warp or shrink. It is known in the timber trade as Gamari. (See *Trewia*, *Euphorbiaceae*). There are two varieties, var. *glaucescens* C. B. Cl. with glabrous glaucous leaves, the glaucous appearance being due to dense microscopic glands or

scales and var. *canescens* Haines in which the leaves are greyish-pubescent beneath with simple, not stellate, hairs.

G. asiatica Linn. is a thorny shrub, wild in the moister parts of India, but often planted in gardens for its bright-yellow flowers and somewhat fleshy leaves.

7. *Clerodendrum* Linn. A genus of many species, mostly shrubby, several of them having very striking and beautiful flowers.

The following is a key to the more common species which are likely to excite the forest officer's curiosity.

Corolla-tube under 2 in. long:

Straggling subscaudent shrubs with white flowers:

Leaves rounded-obovate ... *C. inerme*

Leaves ovate or rhomboid ... *C. phlomoides*

Compact or rigid shrubs or undershrubs:

Panicle large; calyx red in fruit:

Corolla white with pink or red markings

C. petasites

Corolla scarlet ... *C. squamatum*

Panicle narrow; leaves narrow; flowers bluish

C. serratum

Corolla-tube 3 in. long and over; flowers white *C. indicum*

C. inerme Gaertn. is a straggling shrub with a strong rutaceous odour from the numerous glands in the leaves, which are visible beneath as close punctate spots. The flowers are white with red filaments. The drupe is brown and dry. This straggling shrub is found on the sea-coasts of India, Burma and the Andamans. The plant when not in fruit or flower is apt to be mistaken for *Pisonia aculeata* Linn. of the *Nyctaginaceae*, with which it is often associated.

C. phlomoides Linn. f. (*C. phlomoides* Willd.) is a large, usually rambling, shrub found in the drier parts of India, where it is common in hedges. This plant is often planted in gardens for the sake of its pure-white flowers. The fruit of this species is nearly always injured by insect punctures, so that it becomes converted into an oblong fleshy mass, closely invested by the marcescent glandular pubescent corolla.

C. petasites (Lour.) S. Moore (*C. infortunatum* Cooke et al. non Gaertn.) is a robust shrub (reaching a height of 12 ft. or more) which is common throughout India, Burma and the Andamans. The plant when in flower or in fruit is not likely to be mistaken for anything else. The enlarged red calyces are particularly characteristic. De says¹ that in Goalpara this plant has an inflorescence of three different colours, viz., red, light-red and

¹ In *Ind. Forester*, 1940, p. 447.

greenish-cream. The flowers are usually white and are scented in the evening.

C. squamatum Vahl. is a very beautiful shrub when in full flower, with its large orbicular-ovate-cordate leaves and large terminal panicles of which every part is scarlet. It is found in the eastern parts of India from Bihar to Bengal, Assam and Burma, ascending in the hills to 3,000 ft., but is often cultivated in gardens.

C. serratum Moon is a somewhat fleshy perennial shrub with bluish flowers and coarsely serrate leaves. The flowers may have a pinkish tinge with exserted bluish filaments. It is widely used in Indian medicine for a variety of diseases.

C. indicum Ktze. (*C. siphonanthus* R. Br.) is a herbaceous shrub, with tall annual strict hollow stems, common in many parts of India, especially in the moister parts. It is very conspicuous in wet savannahs, where its tall stems with large terminal panicles of white or cream-coloured flowers stand up above the surrounding grass. According to Burkill this is the chief magic plant of northern India. At all events it is now widely used in Indian medicine. The hollow stems are sometimes occupied by ants.

A number of species of *Clerodendrum*, some of them indigenous, others exotic, are cultivated in Indian gardens. One striking species, *C. thomsonae* Balf., is a climber with pure-white calyces which are a contrast to the usually crimson corollas.

8. *Vitex* Linn. This genus contains a number of species with digitate leaves which are distributed over India and Burma.

Key to the species

Shrubs or small trees:

Leaves 1-3-foliate; leaflets sessile ... *V. trifolia*

Leaves 3-5-foliate; leaflets petiolulate, at least the terminal
V. negundo

Trees:

Inflorescence terminal with occasional additional branches in the upper leaf-axils:

Petioles without wings:

Leaflets sessile or nearly so ... *V. pubescens*

Leaflets with petiolules:

Calyx truncate; leaves membranous, 5-foliate

V. quinata

Calyx 4-5-lobed; leaves chartaceous, 5-foliate

V. canescens

Petioles winged; leaflets 3-5-foliate:

Panicle spike-like, interruptedly cymose

V. limonifolia

Panicle lax, elongate

... *V. altissima*

Inflorescence nearly always axillary:

Under-surface of the leaves with shining resinous glands:

Cymes up to 5 in. long ... *V. peduncularis*

Cymes shorter than the petioles ... *V. vestita*

Under-surface of the leaves without shining resinous glands:

Flowers white, hairy, in divaricate cymes; drupe up to 0.75 in. long, dark-purple ... *V. leucoxylon*

Flowers white and purple in lax cymes; drupe up to 0.5 in. long ... *V. glabrata*

In addition to the above the following are found in the Andaman Islands.

Leaves 3-foliate ... *V. diversifolia*

Leaves 5-foliate ... *V. urceolata*

V. trifolia Linn. f. is a small shrub found in the coastal districts. The leaves are much used in Indian medicine, usually in the form of poultices. The root is also used internally.

V. negundo Linn. is a shrub or rarely a small tree, very common in India in waste places. The root and leaves are used medicinally in many parts of India. The var. *incisa* is very different in appearance from the type.

V. pubescens Vahl is a small to moderate-sized deciduous tree found in most parts of India except in the north-west and central areas where it appears to be too dry. The leaves are 3-foliate and the flowers purplish-glandular. The wood does not appear to be used to any extent although it is said to have many of the properties of teak. The bark is grey or greyish-brown, covered with shallow fissures; blaze finely fibrous, yellowish, granular, turning blackish-green.

V. quinata (Lour.) F. N. Williams (*V. heterophylla* Roxb.) is a large tree with corky reticulately fissured bark; blaze light coloured, turning greenish-brown on exposure. The wood is good but owing to the fluting of the trunk it is difficult to get pieces of sufficient size. The tree is found in Assam and Burma.

V. canescens Kurz is a middle-sized tree found in Assam and Burma. The bark is grey, rough and longitudinally furrowed; blaze light-cream but turning a dirty-brown on exposure. The stem is often buttressed.

V. limonifolia Wall. is a small to middle-sized tree which occurs in the southern parts of Bengal and Burma (there is a doubtful record from the Khasi Hills). It can at once be distinguished in the field owing to the fact that the petiole of the digitate leaf is broadly winged.

V. altissima Linn. is a very large deciduous tree with a grey or light-brown scaly characteristic bark; blaze soft, yellow, fibrous with rings of darker-yellow tissue. The tree is quite common in the forests of the Western Ghats. The wood is greyish-brown in colour, with an olive tinge, hard, close-grained and takes a fine polish. This timber is in local demand in Bombay and Madras States.

V. peduncularis Wall. A small or moderate-sized tree with greyish rough bark which exfoliates in irregular flakes; blaze cream-coloured or dull-yellow, streaked with darker specks, turning dirty greenish-brown on exposure. All seedlings of this tree have a winged petiole and the wing sometimes persists in older trees but is usually absent. An infusion of the leaves has a great reputation in Assam as a specific for black-water fever. So far, however, the chemists have not been able to find any substance which could have this effect. Never-the-less, this belief is so strong that the tree has been planted by Forest Departments in malarious localities in case an infusion of the leaves should be wanted. Its home is in eastern India.

V. vestita Wall. is a shrub or small tree with softly hairy leaves and shoots, found in Assam and Burma.

V. leucoxydon Linn. f. is a small to moderate-sized tree with a smooth grey bark, found in the forests of Bombay and Madras States usually along the banks of streams and in nullahs. The wood is said to be pinkish in colour with a satiny lustre and to be close-grained and durable. Nevertheless, it is not used outside the two States.

V. glabrata R. Br. is a large fluted tree, found in north-western India, with ashy-grey bark, corky, smooth, vertically fissured; blaze whitish outside, yellowish inside, turning greenish-black on exposure. The timber of this tree is highly thought of in Assam. The 5-foliolate leaves of this species are very like those of the *Simul*.

V. diversifolia Kurz is a small tree found in the Andamans. The leaves are 3-foliolate, sometimes 1-foliolate, and the flowers are borne in terminal panicles; corolla white, with a blue lower lip.

V. urceolata C. B. Cl. is a moderate-sized tree, also found in the Andamans, and not unlike the last named in appearance. The leaflets are often coarsely crenate-serrate and the flowers are tinged with purple.

9. *Petrea* Linn. *P. volubilis* Linn. is a well-known climber of Indian gardens. The leaves are very harsh to the touch and the flowers are produced in abundant axillary racemes. The so-called bracts of the flower, which are bluish, are really the true calyx-lobes. Inside is found a corona-like structure which is called the calycinal crest. The corolla itself is deep-purple with a white spot on the centre petal. A native of tropical

America, it was introduced into India over a century and a half ago. This plant is known to European residents as Purple Wreath.

10. *Congea* Roxb. *C. tomentosa* Roxb. is a deciduous large scandent shrub, very common in Burma and also in the unadministered territory of the Naga Hills. The flowers are whitish and are borne in small groups surrounded by an involucre of mauve or pink-coloured bracts. It is a very striking plant and deserves to be brought into cultivation in our gardens.

11. *Symphorema* Roxb. This is a genus of rambling shrubs of which two species are common in India and Burma.

Bracts spatulate, papery, thinly pubescent; corolla (lobes and tube) 0.25 in. long ... *S. involucreatum*

Bracts obovate, soft, tomentose; corolla-lobes and tube 0.5-0.75 in. long ... *S. polyandrum*

Both these species are deciduous climbing shrubs with conspicuous bracts and white flowers. The former is common to India and Burma, while the latter is found in the drier parts of central India and Madras State.

12. *Sphenodesma* Jack is a genus of climbing shrubs some of which reach a considerable size. They are easily spotted in the field on account of the involucre below the clusters of the often fragrant flowers. Those bracts which form the involucre are scarious and conspicuously veined.

13. *Avicennia* Linn. This genus contains three species which are exclusively littoral and are found on the shores of India and Burma.

The following key distinguishes the species.

Leaves obtuse at the apex, elliptic-oblong or obovate, attenuate at the base, glabrous and shining above, minutely and closely brownish-pubescent below; anthers exserted; style long ... *A. officinalis*

Leaves acute at the apex; anthers included; style short:

Leaves ovate or lanceolate, cuneate at the base, glabrous and shining above, minutely and closely tawny-pubescent beneath; capsule ovoid, 0.75-1 in. long ... *A. marina*

Leaves lanceolate, acute or acuminate, glabrous and shining above, closely whitish-pubescent beneath; capsule beaked when young, when old ovoid, 0.75 in. long ... *A. alba*

Nobody is likely to mistake *A. officinalis* for anything else, but the other two can easily be confused in the field. The following shows the difference between them as they appear to a forest officer.¹

¹ T. V. Dent, M.B.E., I.F.S.

Avicennia marina

Bark lighter in colour
Blaze white, turning to a
pale shade of brown in
10 minutes
Twigs less straight, grey
on both sides

Leaves on the average
smaller, less acute at
the tip; secondary
nerves less conspicu-
ous below

Fruit often as wide as
long

Avicennia alba

Bark darker
Blaze biscuity, turning to
a darker shade of
brown
Twigs straighter, more
brown and shiny on
the lower side parti-
cularly

Leaves on the average
larger, more acute at
the tip; secondary
nerves a little more
conspicuous

Fruit resembling a gorg-
ed leech

The above differences may look foolish to a worker in a herbarium but are invaluable in the field.

A. officinalis Linn. (*A. tomentosa* Jacq.) is a small tree with a slightly fissured grey lenticellate bark; blaze white or yellowish-white, green under the outer bark. The larger leaves with brown under-surfaces easily separate this species from the other two. It is one of the commonest of mangrove species on the coasts of India, Burma and the Andamans. The wood of this species is peculiar and consists of alternate layers of pore-bearing tissue and loose large-celled tissue without pores. The timber is of little value and is used almost exclusively as fuel.

A. marina (Forsk.) Vierh. is a shrub, often of respectable size, found all round the coasts of India and Burma. The wood has the same peculiar structure as the last and is used for fuel.

A. alba Blume is a larger shrub than the last-named and is found with it in similar habitats.

V. J. Chapman¹ concludes from his experiments on mangroves that the pneumatophores of *Avicennia nitida* (a species not found in India) have at least three functions: (i) they provide a means of gaseous exchange between the atmosphere and the subterranean roots, (ii) they normally bear and maintain the absorbing roots at the most advantageous level in the soil and (iii) they are normal respiratory organs. There is little doubt that the pneumatophores of the Indian species also behave in the same way.

Other species which perhaps deserve notice are:

Citharexylum subserratum Swartz, a tropical American species, sometimes planted in gardens for the sake of its small white fragrant flowers which are borne in long drooping

¹ In *Jour. Linn. Soc. Bot.*, vol. 52, 1944, p. 487.

racemes. It gives an excellent wood, which was termed Bois fidèle by the French, meaning wood that could be relied upon. This name the English corrupted to Fiddle wood, a name which has clung to it in the East.

Duranta plumieri Jacq., the well-known hedge plant, widespread in India, is a native of Mexico and the West Indies. It can be grown with ease from cuttings but is much subject to the attack of *Cuscuta reflexa* Roxb., the dodder.

Holmskioldia sanguinea Retz., is a large climbing or scrambling shrub with drooping branches. It is widespread in India and is extremely handsome in flower and can be easily recognized from the scarlet cylindrical and curved corolla-tube seated in a scarlet saucer-shaped calyx. A yellow-flowered variety is to be found in the Khasi Hills. As a house decoration this plant is very useful as the flowers remain for a long time without falling.

A number of beautiful garden plants also belong to this family.

II. HERBACEAE

51. RANALES

Herbs ; flowers hermaphrodite, actinomorphic or zygomorphic, hemicyclic to cyclic ; ovary apocarpous ; stamens numerous, free ; embryo minute ; endosperm copious.

105. RANUNCULACEAE

Herbs or woody climbers (*Clematis*, *Naravelia*), very rarely shrubs, mostly perennial. Leaves opposite in *Clematis* and *Naravelia*, alternate or radical in all other genera, simple or compound ; stipules absent or rudimentary (*Thalictrum*). Inflorescence of solitary flowers, or racemose or paniculate. Flowers actinomorphic or zygomorphic, hermaphrodite or sometimes dioecious (*Clematis*). Sepals 3 - many, usually five, free, imbricate or valvate, usually green but, when petaloid, coloured. Petals, when present, equal in number to and alternate with the sepals, free, clawed, imbricate, deciduous, often absent. Stamens usually many, hypogynous, free with filiform filaments ; anthers 2-locular. Carpels 1-locular, few to many, rarely reduced to one, free or partly connate ; ovules anatropous, numerous or solitary, ascending or pendulous. Style simple ; stigma on the inner surface of the style at the top, or sessile. Fruit a collection of achenes with long feathery persistent styles or a bunch of follicles. Seeds not arillate, with a small embryo and copious endosperm.

A widespread family with a large altitudinal range. Its interest for the forest officer lies in its value as a source of minor forest-products. A considerable number of the species of the various genera are reputed poisons or are valued for the drugs they contain. The genus *Aconitum* is well known as a source of poison, and the sap of certain species is widely used by aboriginal tribes to make their arrows more deadly. The genera *Ranunculus*, *Helleborus*, *Actaea*, *Anemone*, *Coptis*, *Thalictrum* and others are of repute for their medicinal properties and are largely used in Indian medicine. *Clematis* and *Naravelia* are common climbers in the forests of India, the latter not ascending in the hills above 3,000 ft., the former being found up to 12,000 ft.

Coptis teeta Wall. is a small stemless herb, with a perennial rootstock, which is found in the hills to the north-east of Assam and doubtless also elsewhere in the hills to the north of that State. The roots are collected by the hill-tribes and brought down for sale to Sadiya in Assam, where a considerable demand exists. An infusion of these roots gives a very bitter liquid

which is much valued as a febrifuge. Apart from this, however, it is supposed to cure all sorts of diseases from sore eyes and toothache to a sluggish brain or liver!

The actinomorphous genera require little comment but the zygomorphic genera, *Delphinium* and *Aconitum*, are so irregular that the student often asks why they are included as the only aberrant elements in an otherwise regular family. *Aconitum* has five sepals, of which the posterior one is galeate; eight petals, of which the posterior two (honey leaves) are developed into long-clawed nectaries, which are enveloped by the helmet-shaped posterior sepal; stamens arranged in a spiral, numerous; gynaecium usually of three carpels. *Delphinium* has five sepals which are unequal and petaloid; the posterior one is developed into a conspicuous spur, into which the spurs of the two upper petals are inserted, in addition there may be two lateral petals, which are not spurred, or these may be entirely absent; stamens many; carpels 1-5. Irregularities such as these in an otherwise regular family call for some explanation.

Apart from these irregularities, however, the members of the *Ranunculaceae* agree in the following particulars: (i) All the sepals and petals, no matter what their shape may be, are free and hypogynous. (ii) The stamens are numerous. (iii) The ovary is superior and consists of apocarpous ovaries. (iv) The seeds possess copious endosperm. (v) The embryo is minute and straight. It will thus be seen that the ground-plan of the structure of the flowers is similar for all members and that the presence of irregularly shaped petals, or even their absence, is not a sufficient reason for the relegation of those species which exhibit such features to another family. In 1773 Antoine-Laurent de Jussieu, the French botanist, submitted a paper on the *Ranunculaceae* to the Académie des Sciences. This paper summarizes his conclusions after a comprehensive study of the genera of this family and led him to the grand principle of the relative value of structures. The birth of the so-called Natural System is said to date from the appearance of this paper.

52. BERBERIDALES

Shrubs, sometimes climbing; flowers hypogynous, hermaphrodite, monoecious or dioecious; petals present, small; ovary of 1-3 free carpels; stamens definite, free, opposite the petals, occasionally opening by valves; embryo small or large, straight, curved or horseshoe-shaped; endosperm copious.

106. BERBERIDACEAE 107. MENISPERMACEAE

106. BERBERIDACEAE

Herbs or shrubs often with thick woody or tuberous roots.

Leaves alternate or radical, sometimes pinnately compound, usually exstipulate. Flowers solitary or arranged in panicles or subumbellate, hermaphrodite, regular, usually yellow or white. Petals and sepals similar, 2- to several-seriate, imbricate or the outer valvate, caducous. Stamens 4-9, opposite to the petals, hypogynous, free. Anthers 2-locular, opening by valves. Carpel one; ovules numerous or few. Fruit a berry. Seeds with copious endosperm and a small embryo.

The genus *Berberis* Linn. is exceedingly common in the Himalayas, and as a genus is readily recognized by the spiny branches, dark-green coriaceous leaves and yellow umbellate flowers. It is another matter to run down the species. The fruits are red, blue or black, a circumstance which is sometimes used to assist diagnosis.

Mahonia Nutt., a genus formerly included in *Berberis*, is also readily recognized from its compound leaves, the leaflets of which are very like the leaves of the common holly, and the paniculate yellow flowers and glaucous fruits. *M. sikkimensis* Takeda is common all along the Himalayas, about 6000 ft., and extends into the Naga and Khasi Hills and on into Burma. *M. acanthifolia* G. Don is a very similar shrub but the fruits here are yellow and edible.

One herbaceous species is important as it is the source of a minor forest-product which is greatly sought after in the hills. This is *Podophyllum emodi* Wall., a small herb with peltate orbicular leaves, 3-5-lobed to the midrib and with the segments sharply toothed. The flowers are pure white, about 1.5 in. across. The parts used are the rhizome and roots, containing a resin, which acts as a purgative and has an effect upon the liver, resulting in an increased flow of bile.

107. MENISPERMACEAE

Climbing and twining shrubs, occasionally erect. Leaves alternate, petiolate, often peltate, simple, exstipulate. Flowers dioecious, small, arranged in panicles, cymes or racemes, axillary or borne on the older wood. Sepals in 2-4 series of three sepals each series, imbricate, the outer the smaller. Petals usually six, 2-seriate, free or united (*Cissampelos*), rarely four or eight, very rarely one, three or five or two or none. In the male flowers six stamens, sometimes three or indefinite, when few opposite to the petals, free or variously united; anthers short, usually extrorse, 1-2-locular, dehiscing by a longitudinal transverse or circular slit. In the female flowers staminodes may be present, often absent. Carpels three or six, rarely one or several, free, sessile, or stipitate. Ovules two, soon reduced to one by abortion. Carpels drupaceous. Seeds often curved in the shape of a horseshoe, with uniform or ruminant endosperm or without endosperm.

A family of no importance to the forest officer but the species contained within it are widespread. Some of the species are interesting on account of the anomalous structure of the wood.

Cocculus laurifolius DC., which is a large shrub of the outer Himalayas, is one of these. The activity of the cambium periodically ceases, whereupon a secondary cambium appears in the bark and carries on the growth in thickness, at the same time cutting off a ring of bast tissue on the inner side, so that the latter is eventually surrounded by woody elements. Those species which have a horseshoe-shaped seed are easily recognizable and characteristic of this family.

53. ARISTOLOCHIALES

Soft woody climbers and twiners ; flowers hermaphrodite, monoecious or dioecious, hypogynous or epigynous, zygomorphic, often extravagantly so ; petals absent ; ovary with parietal to axile placentation ; stamens many to few ; embryo small or large ; endosperm present or absent.

108. ARISTOLOCHIACEAE 109. CYTINACEAE

110. NEPENTHACEAE

108. ARISTOLOCHIACEAE

Climbing shrubs. Leaves alternate, simple, entire, exstipulate. Flowers hermaphrodite, zygomorphic, often large and showy, solitary, racemose or cymose. Perianth variously shaped, with valvate lobes. Stamens six or more, in 1-2 series around the apex of the ovary and below the styler column ; filaments very short ; anthers free or adnate, 2-locular, opening lengthwise by slits. Ovary superior, 4-6-locular. Ovules numerous in each loculus. Fruit a capsule. Seed with endosperm.

A family of no importance to the forester but of interest botanically because of the odd, often fantastic shapes assumed by the corolla and for the mechanism of cross-pollination evolved in the family. The perianth is enlarged to an ellipsoidal chamber about the gynostemium, as the ring of stamens below the styles is called. This chamber then contracts to a narrow tube before again expanding into the limb of the corolla. The tube is lined with downwardly directed hairs. Operations commence with the emission from the tubes of the most disgusting odours, apparently with the object of attracting insects. These insects crawl down the tube into the chamber and are prevented from escaping by the downwardly directed hairs. If they bring pollen with them it will be transferred to the stigmas which at this stage are receptive. Unable to escape, the insects congregate at a certain spot on the wall of the

chamber which is translucent and promises a path of escape. Actually it is so situated that it is directly under the anthers so that when dehiscence takes place the insects are drenched with pollen. Before dehiscence the stigmas become non-receptive thus avoiding self-fertilization. After the shedding of pollen the hairs in the throat of the corolla decay so that the insects can crawl out with their load of pollen and transfer it to the next flower they visit. This is altogether a most remarkable and complicated method of pollen-transference.

109. CYTINACEAE

Fleshy parasites with scale-like leaves on the roots of giant vines (*Sapria*). Flowers large, solitary, dioecious, surrounded at the base by large opposite imbricating bracts. Male flowers; perianth tube hemispheric and solid below, cupular above, 10-lobed; lobes imbricate, in two rows; within the cup of a fleshy column. Anthers about twenty, sessile in a ring under the disk of the fleshy column, subglobose, 2-3-locular, opening extrorsely by a single pore. Female flowers; perianth of the male; ovary superior or half inferior, 1-locular; ovules numerous on parietal placentas. Fruit fleshy. Seeds numerous, with endosperm.

The family is included in the book because of one very remarkable parasitic species found in the hill-regions of Assam. This is *Sapria himalayana* Griff., which is found parasitic on the roots of *Cissus elongata*, a giant vine of the hill-forests.

The flower-buds, rosy-pink in colour, appear on the surface of the soil towards the end of the rains. They are then about the size of a grape-fruit. On opening, the lobes of the perianth are turned backwards, exposing the throat of the perianth, from which is emitted a most disgusting odour. The diameter of the opened flower is about 14 in. The colour of the reflexed lobes is a deep-crimson and their upper-surface is covered with yellowish papillae. Just at the root of the perianth-lobes is what looks like a perforated disk fimbriate on the margins. Beetles have been found in the interior of these flowers and the mephitic odours seem to attract various other insects.

Griffith found this plant in the Mishmi Hills and the writer in the Balipara Frontier Tract. The fact that it flowers at a time when the forests are unlikely to be visited by a botanist no doubt accounts for its supposed rarity. Actually it is not at all uncommon though rarely collected.

110. NEPENTHACEAE

Scrambling or sprawling shrubs. Leaves alternate, sessile or petiolate, the blade, when adult, being produced into a tendril,

pitcher (*ascidium*) and a lid (*operculum*). Flowers small, actinomorphic, dioecious, arranged in crowded panicles. Perianth of 3-4 sepals, imbricate, separate or connate at the base, provided with nectaries within. Male flowers; stamens up to twenty-four; filaments connate into a column; anthers crowded into a mass, 2-locular, opening lengthwise. Female flower; ovary of four carpels, rarely three, opposite the tepals, 3-4-locular, ovules numerous in many series on the central placentas. Fruit a capsule, sessile or shortly stipitate, loculicidally dehiscent. Seeds with endosperm.

The Pitcher plants, as the members of this family are called, belong to the genus *Nepenthes*. There are many species of this genus in Malaysia, it occurs in Madagascar, two species inhabit Ceylon, while only one species is found in India. The latter is *N. khasiana* Hook. f., found in the Khasi Hills and in the valley of the Someswari in the Garo Hills, both districts of Assam. In the Khasi Hills the species is found as a sprawler on the plateau at an altitude of 4000 ft. or a little lower. Here in the winter the nights can be very cold indeed and while humidity is high in the rainy season it may be quite dry in March and April. It can therefore be assumed that *N. khasiana* is exceptionally hardy for its genus, the members of which (except a couple found on Kinabalu, Borneo, at 9000 ft.) live in the damp steamy forests of Malaysia where temperatures and humidity are high.

The leaf of the genus is a quite extraordinary structure. The winged or expanded petiole passes insensibly into the elongated blade, from the tip of which emerges a long whip-like structure, the tendril. The tendril is non-functional in rosette species but in the climbing species grasps and winds round supports and assists the plant to climb. The pitcher is fixed by its base to the tip of the tendril and assumes an erect position, the open mouth being hooded over by the operculum or lid which during development seals the opening.

Various theories have been advanced to explain the morphology of the *Nepenthes* leaf and there is not final agreement on the point by botanists. One theory, that of Troll, has had some measure of success. He divides the whole organ into a leaf-base and blade. The leaf-base consists of a clasping bottom leaf-zone, which is contracted briefly and then expands to form the conspicuous lamina. The blade consists of the petiole, which behaves as a tendril, and the true leaf-blade. The true leaf-blade is the pitcher which is peltately attached to the tip of the tendril.

The pitchers, as is well known, serve as receptacles in which insects are captured, killed and digested. The digestion process has been the subject of numerous investigations. It appears that the fluid in unopened pitchers is sterile and already acid,

but that it requires additional acid before digestion can begin. The acid is believed to be produced as a result of stimulus, by the glands on the inner surface of the pitcher, when an insect falls into the fluid at the bottom of the pitcher. It seems certain that a catheptic proteinase is secreted by the pitchers of *Nepenthes*. It is also probable that tryptic digestion takes place in the absence of bacteria.

Hooker has mentioned that he had never found any insects in the pitchers of the plants found by him in the Khasi Hills, and that he was puzzled to account for this. Actually the first plant found wild by the writer had attention irresistibly drawn to it by the stench of putrescent matter which issued from the pitchers. The pitchers were loaded with decaying insects of all kinds, including larvae. It can be assumed therefore that the Indian plant is quite normal in its food requirements.

54. RESEDALES

Perennial herbs, sometimes woody ; flowers hermaphrodite, zygomorphic ; ovary of 2-6 free or connate carpels ; ovules numerous on parietal placentas ; stamens few to many, embryo curved or folded ; endosperm absent.

III. RESEDACEAE

One species in India is a woody shrub, but the remainder of the family consists of annual or perennial herbs with watery juice. Leaves alternate, simple entire or pinnately divided. Stipules minute, gland-like. Flowers zygomorphic, hermaphrodite or rarely dioecious, usually arranged in racemes, sometimes spicate. Calyx persistent, 4-8-partite, more or less zygomorphic. Petals 4-8, or two (*Oligomeris*) or none (*Ochradenus*), hypogynous, entire, or laciniate, often with a scale at the base, free or somewhat connate (*Oligomeris*). Disk present, fleshy, often dilated on the adaxial side. Stamens 3-40, inserted within the disk. Anthers introrse, 2-locular, dehiscing by longitudinal slits. Ovary of 2-6 free or connate carpels. Ovules numerous on parietal placentas. Fruit a gaping capsule or baccate. Seeds numerous, reniform or horseshoe-shaped, without endosperm.

Ochradenus baccatus Delile is the only woody species of this family found in the Indian Peninsula, where it occurs in the very dry arid regions of Sind and Baluchistan. It is easily recognized from the long rigid racemes with minute flowers, the fleshy leaves and the unpleasant smell of all parts.

The well-known garden plant, the Mignonette, is *Reseda odorata* Linn.

55. POLYGONALES

Herbaceous, stipulate ; flowers actinomorphic, small, hermaphrodite or unisexual ; petals absent ; ovary 1-locular, 1-ovuled ; stamens 6-9 ; embryo straight or curved ; endosperm copious.

112. POLYGONACEAE

Herbs, rarely shrubs. Leaves alternate, rarely opposite, simple, entire or serrulate, often gland-dotted ; stipules ochreate (sheathing the base of the petiole). Flowers hermaphrodite or dioecious, usually small, actinomorphic, clustered, with the cluster racemose or paniculate. Perianth of 3-6 sepals, green or coloured, imbricate. Petals absent. Stamens 5-8, when equal in number to the perianth segments, opposite to them ; anthers 2-locular, opening lengthwise by slits. Ovary superior, sessile, 1-locular. Ovule one, basal, orthotropous. Fruit a nut, enclosed in the perianth which may be accrescent. Seeds with endosperm.

This family is in the main a herbaceous one but one species reaches small-tree size in India. This is *Calligonum polygonoides* which sometimes reaches a height of 25 ft. It is an inhabitant of the drier and more arid area of north-west India. It is a very nearly leafless shrub or small tree, the leaves being reduced to minute scales. The function of the leaves is taken over by the bright-green twigs. The flowers are in fascicles of 2-5, in the axils of the stipules, and are conspicuously pink in colour. Altogether a very distinctive species.

Many species of *Polygonum* Linn., some of them handsome enough to be a desirable addition to a garden, are found in hills and plains. Most of them have leaves which have a 'V for Victory' on them, almost as if it were painted on.

Rhubarb, *Rheum* sp., belongs to this family, and apart from the cultivated species, *R. rhaponticum* Linn., several other species are found growing wild in the Himalayas. It may be mentioned that the leaf-stalks of the wild species are by no means to be despised. The Lahul species is excellent stewed and quite the equal of the cultivated species. The leaf-stalks eaten uncooked have a very violent purgative action and are better avoided in this condition.

56. CHENOPODIALES

Herbaceous, exstipulate ; flowers actinomorphic, hermaphrodite or unisexual ; petals absent ; ovary superior, 1-locular, 1-ovuled ; stamens same number as tepals and opposite to them ; embryo curved ; endosperm copious.

113. CHENOPODIACEAE 114. AMARANTACEAE

113. CHENOPODIACEAE

Annual or perennial herbs or shrubs with jointed stems.

Leaves simple, alternate, exstipulate. Flowers hermaphrodite, polygamous or dioecious, actinomorphic, very small, usually bracteate. Perianth of 3-5, free or connate sepals, persistent, imbricate in the bud. Petals absent. Stamens the same number as the sepals and opposite to them, hypogynous or perigynous, free or connate at the base; anthers 2-locular, opening by slits. Ovary 1-locular with 3-5 styles. Ovule one, erect or suspended from a basal funicle. Fruit an indehiscent nut, often enclosed in the enlarged, sometimes fleshy, perianth. Seeds with or without endosperm.

Species of *Suaeda* Forsk. and *Salsola* Linn. are found in the salt plains of north-west India and also on the north-west coasts. A few other species reach shrub size and they are mostly inhabitants of the Punjab and Sind.

114. AMARANTACEAE

Herbs, rarely shrubs or undershrubs. Leaves opposite or alternate, simple, usually entire exstipulate. Flowers hermaphrodite, sometimes polygamous or unisexual, actinomorphic, arranged in dense heads, spikes or racemes, often accompanied by scarious bracts. Sepals five, persistent, imbricate in the bud, often coloured, sometimes scarious or membranous. Petals absent. Stamens as many as the sepals and opposite to them, hypogynous, filaments united below into a short tube; anthers 1-2-locular; opening by slits; pollen spherical with numerous pores. Ovary 1-locular, ovule one, rarely more (*Celosia*), erect or pendulous from a slender basal funicle. Fruit a utricle, dehiscing by a lid, or indehiscent. Seeds with endosperm.

A family mainly of weedy species, but several other species become small shrubs in the deserts of north-west India and in the sub-Himalayan tract of the Punjab. *Deeringia celosioides* R. Br. is a scrambling undershrub extending all along the Himalayas into Assam and on into Burma. The long racemes of white flowers, succeeded by long racemes of small red berries, are sufficiently striking as to require no effort of the memory to retain a picture of the species. *Bosia amherstiana* Hook. f., a glabrous straggling shrub of the north-west Himalayas, is another of those species once seen, never forgotten. The flowers at the tips of the branches are surrounded by white-margined green bracts. The berries are bright-scarlet. Two species of *Aerva* Forsk., *A. tomentosa* Forsk. and *A. scandens* Wall., are small shrubs of the Punjab and the deserts of Sind and Baluchistan. *Stilbanthus scandens* Hook. f., a climber of the hills bordering Assam, grows to an enormous size, the trunk quite often reaching a girth of 3 ft. while the stem ascends the tallest trees and the branches cover the foliage of the support with white flowers and leaves.

57. LYTHRACEAE

Herbaceous, some trees; flowers actinomorphic, hermaphrodite, perigynous to epigynous; petals present, clawed; ovary superior with axile placentation; stamens 4-8 or more; embryo straight; endosperm absent.

115. LYTHRACEAE

Herbs, shrubs or trees. Leaves opposite or whorled, exstipulate or stipules very small. Inflorescence of axillary or terminal panicles, or in lateral clusters from the axils of fallen leaves. Flowers actinomorphic, often showy. Calyx-tube free, ribbed, lobed; lobes six, valvate in the bud, often with appendages between the lobes. Petals six in number, alternate with the calyx-lobes and inserted between them on the tube, imbricate, crumpled in the bud, often clawed (*Lagerstroemia*); margins undulate. Stamens numerous or twelve, inserted below the petals, often below the ovary; filaments inflexed in the bud. Anthers 2-locular, dehiscing by longitudinal slits. Ovary superior, free, 2-6-locular; ovules numerous, attached to axile placentas. Fruit a capsule, dehiscing loculicidally or irregularly. Seeds numerous, winged or not, without endosperm. Embryo straight.

Students who are inclined to be superficial are apt to confuse this family, strange though it may seem, with the *Rosaceae*. The fact that the leaves are opposite should be quite enough to prevent such a mistake being made, as also the existence of a loculicidal capsular fruit.

The characters outlined above are those of *Lythraceae sensu stricto*. *Lythraceae* as known to Bentham and Hooker has been split up into four or five families of which four (including *Lythraceae sensu stricto*) are found in India.

The following key will be found of use in separating them.

Ovary superior:

Fruit a capsule:

Stamens 12-numerous; petals present *Lythraceae*

Stamens 4-5; petals absent ... *Crypteroniaceae*

Fruit a berry ... *Sonneratiaceae*

Ovary inferior ... *Punicaceae*

Lythraceae. In this family there are three genera, one with large clawed petals, usually trees, *Lagerstroemia* Linn., and the other with small petals without claws, a shrub, *Woodfordia* Salisb.; both of these have normal flat leaves.

The third genus is *Pemphis* Forst. *P. acidula* Forst. is a widely distributed shrub with reddish flowers, usually found on open sea-coasts where it is exposed to the monsoon. It reaches a height of 20 ft. and looks rather like a *Tamarix* on account of the numerous fine often leafless branches. It is very

often associated with *Tournefortia argentea* Linn. f. (*Boraginaceae*). Where it is actually exposed to driven spray, it subsides as a small gnarled bush, sprawling over the rocks.

Lagerstroemia Linn. To this genus belong some of India's important timber trees. Most of them possess showy flowers of very definite characteristics. The widely spreading clawed and crinkled petals with undulate margins, and the occasionally ribbed calyx, are features which identify the genus without fail. The fruits, too, are typical of the genus. These are woody fig-like capsules, supported by the persistent calyx, loculicidally dehiscent. The seeds have a narrow membranous wing. *L. indica* Linn., with white-pink or mauve flowers, is very common in Indian gardens.

The bark of species of *Lagerstroemia* is dirty-white or grey or even reddish on the outside, with a white blaze, which, next the wood, rapidly turns a mauve colour on exposure to the air.

The following is a key to the more important species of *Lagerstroemia*.

Calyx terete, not ribbed:

Calyx and other parts glabrous:

Flowers small, 0.5 in. in diameter:

Leaves rounded at the base ... *L. parviflora*

Leaves narrowed at the base ... *L. lanceolata*

Flowers about 1 in. or more in diameter ... *L. indica*

Calyx covered with a rusty tomentum ... *L. calyculata*

Calyx ribbed or sulcate:

Inflorescence covered with a rusty or white floccose tomentum:

Adult leaves glabrous; tomentum rusty ... *L. floribunda*

Adult leaves puberulous; tomentum whitish ... *L. tomentosa*

Inflorescence pruinose or minutely puberulous:

Leaves whitish-glaucous beneath ... *L. hypoleuca*

Leaves green:

Flowers in ample terminal panicles; calyx strongly ribbed ... *L. speciosa*

Flowers in small terminal panicles; calyx finely sulcate but not ribbed ... *L. macrocarpa*

L. parviflora Roxb. A very common deciduous co-dominant with *Shorea robusta*, wherever that tree is found in India, but it is also characteristic of dry mixed deciduous forest in other parts. It reaches a large size in favourable habitats. The bark is light-grey to reddish in colour, exfoliating in narrow longitudinal flakes; blaze brown. The wood is hard and durable.

L. lanceolata Wall. A large deciduous tree found in the Western Ghats, where it is common from Bombay State to Travancore. It is usually found in the mixed deciduous forest

but also isolated specimens are found in evergreen forest. The bark is smooth and yellowish-white and exfoliates in large papery strips. The wood is used for building, furniture and other purposes. It is known in the trade as Benteak.

L. floribunda Jack. This is a large deciduous tree found, as far as we are concerned, in Mergui, Burma, only. The flowers, which are borne in large terminal panicles, are rose-coloured turning white, the inflorescence being covered with a rusty tomentum.

L. tomentosa Presl. This deciduous tree is found in Burma, where it reaches a height of 100 ft. or more. According to Troup it is found in evergreen and semi-evergreen forest, and also in mixed deciduous forest, where it has as a companion *Xylia dolabriformis*. The bark of this tree is a light-grey to greyish-brown and is covered with longitudinal cracks. The wood is only moderately hard but is useful for a variety of purposes, among which is match-splints.

L. hypoleuca Kurz. This large deciduous tree is only found in the deciduous forests of the Andaman Islands where it is one of the principal timbers. The bark is thin and white; blaze a light-brown turning black or purple near the sap-wood. The leaves turn red before falling. The flowers are large and handsome, lilac in colour, and are borne in long terminal panicles. The timber has a reputation and is known as Jarul in the trade.

L. speciosa Pers. (*L. flos-reginae* Retz.). One of the most striking trees in India, where it is found in Assam, Bengal, western and southern India, and in Burma. It is extremely handsome when in flower and is very widely planted as an avenue tree and in gardens for its magnificent mauve or pink flowers. The bark is grey or yellowish-grey, exfoliating in thin irregular flakes. It is not often that a tree with handsome flowers has a superior timber. This species is an exception for Jarul, as the timber is known in the trade, has a very high reputation as a strong, hard and durable wood. This species is found typically on river-banks, low-lying swampy places and in similar habitats. It can grow to a very large size in moist well-drained loam. Two forms are known in Assam. One, *kata jarul*, is spiny and crooked-boled; the other, *lota jarul*, grows straight and tall and has no spines. There does not appear to be any difference between them in flowers and fruit.

L. macrocarpa Wall. is a moderate-sized deciduous tree resembling *L. speciosa*, but with larger leaves and flowers. It is only found in Burma, chiefly in the *Dipterocarpus tuberculatus* forests.

L. calyculata Kurz is a moderate-sized tree which grows in Burma. Its timber is apparently not much used. *L. indica* Linn., a native of China, is often grown in gardens for its handsome flowers.

Woodfordia Salisb. *W. fruticosa* Kurz (*W. floribunda* Salisb.) is a species which is found in the drier parts of India and Burma. It is a large deciduous shrub with scarlet flowers and lanceolate-caudate leaves, whitish beneath. It is exceedingly common in the Doon. The flowers yield a dye which is yellow or red, and it is said that this is the dye which is so familiar during the Holi festival. The flowers are also medicinal.

Lawsonia inermis Lam. (*L. alba* Lam.), the Henna tree, is a thorny or unarmed shrub or small tree which is often cultivated in gardens in India for its very fragrant flowers. The leaves are the source of the henna dye, and are also used medicinally in various ways.

58. PRIMULALES

Herbs ; flowers actinomorphic, hermaphrodite ; petals united ; ovary superior, 1-locular, with free central basal placentation ; ovules many ; stamens opposite corolla-lobe ; embryo straight, small ; endosperm copious.

II6. PRIMULACEAE II7. PLUMBAGINACEAE

II6. PRIMULACEAE

Herbs with radical leaves, or, if cauline leaves, the latter opposite or alternate or whorled, simple or lobed, exstipulate. Flowers actinomorphic, sometimes dimorphic, hermaphrodite, solitary or arranged in umbels or panicles. Calyx inferior, gamosepalous, 5-lobed, persistent. Corolla hypogynous, tubular, rotate, bell- or funnel-shaped, usually 5-lobed. Stamens five, on the corolla-tube opposite the lobes, occasionally with alternating staminodes. Ovary 1-locular, with a free central placenta ; ovules numerous. Fruit a capsule, variously dehiscent. Seeds with a copious endosperm.

A family of no forest importance, but anybody with any claim to a knowledge of botany must know something about it if only for the sake of running down some of the pretty flowers to be found in the forests of plains and hills. The yellow-flowered *Lysimachia* spp. are very common all over India in the plains and forests. The Pimpernel, with blue or red flowers, *Anagallis arvensis* Linn., is common in the Doon. On the high hills some of the most beautiful flowers of the alpine meadows belong to the genera *Primula*, *Androsace*, etc.

The family is a favourite one with students who rarely fail to place their specimen with regular 5-lobed gamopetalous corolla, and with a free central placenta with many ovules, in the correct family.

117. PLUMBAGINACEAE

Small trees, undershrubs or herbs. Leaves simple, alternate. Flowers capitate, racemed or paniced in terminal scapes or peduncles with the bracts often scarious and sheathing the flowers; bracteoles two. Calyx inferior, tubular, 5-10-ribbed; mouth frequently funnel-shaped, scarious. Petals free or gamopetalous with a very short tube, rarely with a linear tube. Stamens five, opposite the petals and often adnate below to the corolla. Ovary superior, 1-locular, 5-angular above, with five styles. Ovule one, pendulous from a basal ascending funicle, anatropous. Fruit capsular. Seeds without endosperm.

Apart from garden-plants two species of the family grow into small trees or shrubs.

Aegialitis rotundifolia Roxb. is a small tree with leathery leaves and pale-yellow and white flowers which is found in the mangrove swamps and tidal forests of Orissa, Bengal and Burma. The wood is abnormal and resembles that of a monocotyledonous species in that it consists of soft cellular tissue studded with scattered small patches of pore-bearing wood.

Vogelia indica Gibson is found in the arid parts of north-west India and in the northern parts of the Deccan. The alternate leaves are amplexicaul or even perfoliate.

59. SARRACENIALES

Herbaceous; leaves with stipitate glands; flowers actinomorphic, hermaphrodite, small; ovary free, 1-locular; ovules on parietal placentas; stamens few to numerous; embryo small, straight; endosperm copious.

118. DROSERACEAE

Herbs, stemless with rosettes of leaves, adapted for the trapping of insects by means of sticky stipitate glands. Stipules absent or adnate to the petiole. Flowers hermaphrodite, actinomorphic, arranged in usually circinate cymes at the tip of an erect peduncle. Sepals five, more or less connate at the base, imbricate, persistent. Petals five, hypogynous, free. Anthers 2-locular, extrorse, opening by slits. Ovary free, 1-locular, with parietal placentas and 2-5 styles; ovules parietal, numerous. Capsules loculicidally dehiscent. Seeds with endosperm.

The Sundews, as the species of *Drosera*, the only genus of the family found in India, are called, are usually to be found in boggy places, particularly in *Sphagnum* bogs in European lands. In India, however, they are found in open places from the plains to 12,000 ft. in the Himalayas, Assam hills and elsewhere. In the hill-species a prominent tuber is found at the base of the plant and the plants actually behave as cryptophytes.

In Tibet, where they live on open hill-sides at 12,000 ft., it is only the possession of the tuber that enables the plants to survive the very severe winter.

The whole plant turns dark-red when dried and all herbarium specimens give a very poor idea of what the plant actually looks like.

It is, of course, the leaf that excites attention. The leaves are spatulate in shape, concave and covered on the upper surface by stalked glands or tentacles, each with a drop of viscid mucilage at the tip. In addition to these tentacles other sessile glands, or papillae, are to be found on both surfaces of the leaf. All the glands on the leaf are capable of absorbing nutritive substances.

The stimulation of an insect trapped by the viscid glands causes those in the neighbourhood to bend towards the insect and the leaf itself to bend over so that the insect is completely covered. From experiments carried out by several research workers it has been proved beyond doubt that the carnivorous habit of this plant is of the greatest advantage to it.

60. UMBELLALES

Herbaceous ; flowers hermaphrodite, small, arranged in umbels, usually actinomorphic ; petals present ; ovary inferior, 2-locular, with one pendulous ovule in each loculus ; stamens five, alternate with the petals ; embryo minute ; endosperm copious.

119. UMBELLIFERAE

Herbaceous to somewhat woody ; stems furrowed, with conspicuous pith ; leaves simple, or more often divided or cut in various ways, with a sheath at the base of the petiole, flowers hermaphrodite, actinomorphic to slightly zygomorphic. Inflorescence of simple or compound umbels. Calyx adnate to the ovary, 5-lobed, corolla of five separate petals, valvate or slightly imbricate, epigynous, caducous. Stamens five, epigynous, alternate with the petals ; anthers 2-locular, opening lengthwise. Ovary inferior, 2-locular ; ovules solitary in each loculus, pendulous. Fruit of two mericarps, prominently ribbed and with parallel vittae. Seeds with copious endosperm and a small embryo.

The family *Umbelliferae* is not one which is likely to trouble the forest officer, since it can usually be recognized at a glance. It is included here because it is sometimes made available for practical work and a description of the family is given for the sake of completeness.

Several cold-weather vegetables are members of the family : such are Parsnips (*Peucedanum sativum* Benth. et Hook. f.),

Carrots (*Daucus carota* L.) and Celery (*Apium graveolens* L.). Caraway-seeds are obtained from *Carum carvi* Linn., a common herb of the Himalayas. The Fennel, *Foeniculum vulgare*, and Coriander, *Coriandrum sativum*, are cultivated throughout India.

61. CAMPANALES

Herbaceous to somewhat woody; corolla gamopetalous; flowers zygomorphic, epigynous, hermaphrodite; ovary inferior, 1-2-locular; ovules one or more in each loculus; stamens five; anthers free or connivent round the style; embryo straight; endosperm copious.

120. GOODENIACEAE

Herbs or undershrubs with large pith. Leaves alternate, simple, exstipulate. Flowers hermaphrodite, zygomorphic, solitary or in short axillary cymes, or paniculate. Calyx adnate to the ovary, 5-lobed. Corolla gamopetalous, 5-lobed, 2-lipped or rarely 1-lipped; lobes valvate. Stamens five, inserted at the base of the tube, alternate with the corolla-lobes; anthers 2-locular, opening lengthwise by slits. Ovary inferior, 2-locular; ovules basal, one in each loculus; style simple, a cup-shaped indusium containing the stigma. Fruit a drupe or berry. Seeds with copious endosperm.

Several species of the genus *Scaevola* Linn. are to be found on the coasts of India, Burma and the Andamans. One of these, *S. koenigii* Vahl, a pretty shrub with light-green fleshy foliage and white flowers about 1 in. across, is common on all the seashores of the Andamans and from Sind round the coast to Burma and Malay. *S. plumieri* Vahl is a similar species and is found in the same situations.

62. ASTERALES

Woody to herbaceous; flowers in capitula surrounded by an involucre of bracts, hermaphrodite or unisexual, inner usually actinomorphic, outer sometimes zygomorphic; ovary inferior, 1-locular, 1-ovuled; stamens five or four, epipetalous; embryo straight; endosperm absent.

121. COMPOSITAE

Herbs, rarely shrubs or trees. Leaves alternate or opposite, simple or variously divided, exstipulate. Inflorescence a capitulum, surrounded by an involucre of one or more series of free or connate bracts, rarely 1-flowered, sometimes few-flowered. Flowers hermaphrodite or unisexual, rarely dioecious, sometimes neuter, the outer flowers often ligulate, the inner tubular and then actinomorphic, seated on a receptacle. Receptacle some-

times furnished with bracteoles and then called paleaceous, sometimes naked or foveolate. Calyx superior, reduced to scales, hairs or absent; these appendages constituting the pappus in fruit. Corolla epigynous, tubular or somewhat funnel-shaped, 2-5-toothed or cleft or ligulate or somewhat bilabiate. Stamens five, rarely four, inserted in the corolla-tube; filaments free; anthers syngenesious, 2-locular, often tailed or spurred, opening by slits; pollen spinulose or verrucose. Ovary inferior, 1-locular; ovule one, basal, anatropous; style 2-fid, or arms connate in barren forests. Fruit (cypsela) dry, indehiscent, closely investing the exalbuminous seed. Pappus sometimes caducous or absent, usually present. Embryo straight.

Compositae is the largest family of flowering plants, comprising as it does about 1,000 genera and over 23,000 species. Very few of the species are trees. The most remarkable are the tree species of *Senecio*, a genus which is usually composed of low herbs or half-shrubs. At the higher elevations in Central Africa, Madagascar and St Helena, however, the genus is represented by tree-like forms with single stems bearing large leaves, which give the landscape a strange unearthly aspect.

A very large number of species have become established in our gardens and India has supplied a number of *Compositae* to European gardens which are considered weeds, and undesirable weeds at that, in this country. Examples are *Ageratum* and *Eupatorium*.

Apart from garden-plants a very large number of *Compositae* are of the highest value for the drugs or dyes they furnish.

Nobody is likely to make a mistake when confronted with the family *Compositae*. Of the very numerous species found inside and outside the forest a few grow into small trees. They all belong to the genus *Vernonia*.

The following is a key to the species.

Heads 1-flowered:

Leaves oblanceolate, scabrid-pubescent below

V. shevaroyensis

Leaves elliptic-oblong, densely brown-tomentose below

V. monosis

Leaves elliptic-oblong, pubescent below

V. arborea

Heads more than 1-flowered:

Leaves glabrous on both sides ...

V. travancorica

Leaves pubescent, at least beneath on the nerves:

Achenes hairy ...

V. parryae

Achenes glabrous:

Ribs on achene definite:

Pappus white ...

V. volkameriaefolia

Pappus reddish ...

V. talaumifolia

Ribs on achene obscure ...

V. arborea

Of these *V. shevaroyensis* Gamble, *V. monosis* C. B. Cl. and *V. travancorica* Hook. f. are confined to Madras State. *V. parryae* Fischer is found only in the Lushai Hills. *V. arborea* Ham., *V. talaumifolia* Hook. f., and *V. volkammeriaefolia* DC. are found in Bengal, Assam and Burma.

Notonia grandiflora DC. is a perennial shrubby species with a soft stem which reaches 8 in. in diameter. It is found in western India and in Ceylon. The stem when gashed sends forth a large quantity of white milk.

63. SOLANALES

Herbaceous to semi-woody, sometimes climbing; flowers with actinomorphic corolla, hermaphrodite; ovary superior, 1-4-locular, often 2-locular; ovules axile, numerous to solitary; stamens five, alternate with the corolla-lobes; embryo often curved; endosperm scanty or copious.

I22. SOLANACEAE I23. CONVULVULACEAE

I22. SOLANACEAE

Herbs, more rarely erect or climbing shrubs (*Datura*, *Solanum*). Leaves alternate, entire, simple, rarely lobed or pinnate, exstipulate, often in unequal pairs towards the inflorescence. Flowers often large and showy, hermaphrodite, actinomorphic. Calyx-tube 5-lobed, persistent. Corolla sympetalous, 5-lobed, usually plicate in the bud or valvate, rarely imbricate. Stamens five, inserted on the corolla-tube, alternate with the lobes; anthers 2-locular, sometimes dehiscent by apical pores. Ovary 2-locular, with the loculi sometimes again divided by a false septum. Ovules numerous, axile. Fruit a capsule or berry.

The family consists of herbs, climbers and shrubs, some of which like *Datura*, *Atropa* etc. are extremely poisonous. The Tree Tomato, *Cyphomandra betacea* Miers, is occasionally cultivated in the hills; it gives a fruit of surpassing excellence for stews. *Solanum macranthum* Dun., the Potato tree, is a native of Brazil, but is cultivated in northern India in gardens. It is a small thorny tree with white or blue flowers and deeply pinnately lobed leaves. The berry is about 2 in. in diameter and turns a very bright ochre-yellow.

I23. CONVULVULACEAE

Herbs or shrubs, often climbing, with milky juice. Leaves alternate, simple, exstipulate, sometimes absent (*Cuscuta*). Flowers hermaphrodite, actinomorphic, from very small to large and showy, arranged in cymes, cymose panicles or solitary.

Sepals five, free or connate into a tube at the base, imbricate, often accrescent in the fruit. Corolla funnel-shaped, campanulate or even rotate with an entire limb or deeply 5-lobed. Stamens five, rarely four, inserted at the base of the tube and alternate with the lobes; anthers 2-locular, opening lengthwise. Ovary 1-4-locular, sunk in the disk. Ovules two in each loculus, erect, collateral, anatropous. Fruit a capsule or fleshy and indehiscent. Seeds with or without endosperm.

A large number of species of this family are twiners or climbing shrubs and many of them have attractive flowers. One species is a leafless parasite, *Cuscuta reflexa* Roxb., which is extensive in India and is often found tumbling in cascades over *Zizyphus* bushes, *Duranta plumieri*, *Vitex negundo* and other shrubs; in fact it seems to prefer these species above all others. That does not mean to say that other species are immune, for actually *Cuscuta* will attack most Angiosperms. The seed germinates on the ground in the usual way, but as soon as the seedling attaches itself to a host the base dies and thereafter it behaves as a holoparasite.

64. PERSONALES

Herbaceous to shrubby, very rarely trees (*Wightia*); flowers zygomorphic, hermaphrodite; corolla gamopetalous; ovary superior, 2-locular with numerous axile ovules; stamens often four, didynamous, epipetalous; embryo straight or slightly curved; endosperm fleshy.

124. SCROPHULARIACEAE 125. ACANTHACEAE

124. SCROPHULARIACEAE

Herbs, rarely shrubs or trees (*Wightia*). Leaves alternate, opposite, simple, exstipulate. Inflorescence various, sometimes in narrow axillary thyrsi (*Wightia*). Flowers zygomorphic; hermaphrodite, occasionally regular (*Scoparia*, *Veronica*). Calyx persistent, 4-5-merous, valvate or variously imbricate in the bud. Corolla gamopetalous, 4-5-lobed, often more or less 2-lipped; lobes imbricate. Stamens four, rarely five, perfect, often didynamous, with the posterior rudimentary, or sometimes only two; anthers 2-locular, opening by longitudinal slits, or loculi confluent at the apex and opening by one continuous slit, sometimes anthers connivent in pairs. Disk hypogynous, annular or unilateral. Ovary sessile, 2-locular; ovules many, on the central axile placentas; style terminal, simple or 2-lobed; stigma capitellate on the upper side of the lobes. Fruit a capsule, rarely baccate. Seeds numerous, with a fleshy endosperm; embryo straight or curved.

This family is for the most part herbaceous but there are two woody genera in India and Burma, which may be distinguished by the following key.

- | | | |
|----------------------------------|-----|---------------------|
| Calyx 3-4-lobed; anther glabrous | ... | 1. <i>Wightia</i> |
| Calyx 5-lobed; anther bearded | ... | 2. <i>Brandisia</i> |

1. *Wightia* Wall. A genus with three species in India and Burma, of which two, *W. lacei* Craib and *W. aplinii* Craib, are endemic to Burma. The species are of considerable interest, not only because they are tree representatives of a family which is otherwise almost entirely herbaceous, but because of their mode of life. They germinate in the ordinary way and if isolated will grow into small straight trees. If, however, there is another tree close at hand, the *Wightia* species develops horizontal clasping roots which encircle the support, and then it proceeds to climb by means of these roots and eventually overtops the crown of its support. This, at least, is the method of growth of *W. speciosissima* (D. Don) Merr. (*W. gigantea* Wall.), a semi-epiphyte of the hill-forests of Bengal, Assam and Burma, where it may be seen bearing its erect thyrsi of pink flowers in the autumn high above the canopy of the surrounding trees. Craib does not tell us the habit of growth of the two Burmese species described by him. *W. lacei*, he says, *fide* Lace, is a tree of about 100 ft. in height, and it is likely, therefore, that they follow the same mode of life.

2. *Brandisia* Hook. f. et Thoms. is represented by *B. discolor* Hook. f. et Thoms., an evergreen scrambling shrub found in Burma.

125. ACANTHACEAE

Shrubs with jointed stems and branches and tumid nodes, or herbs. Leaves opposite, simple, often lineate with cystoliths, which are very evident when the leaf is dry, exstipulate. Inflorescence of spikes, racemes or fascicles. Flowers zygomorphic, often with conspicuous bracts, bracteolate, hermaphrodite. Calyx of 4-5 equal or unequal segments, or reduced to a truncate, entire or toothed ring. Corolla gamopetalous, 2-lipped; upper lip bifid, sometimes obsolete; lower lip 3-lobed, imbricate in the bud. Stamens inserted on the corolla-tube, usually four, didynamous, the fifth or posterior rudimentary or absent, sometimes two; filaments filiform or subulate; anthers 2-locular or 1-locular by reduction; loculi confluent or separated, sometimes one much smaller than the other, opening by longitudinal slits. Disk present. Ovary superior, 2-locular; ovules two or more in each loculus; style terminal; stigma usually 2-fid. Fruit a capsule, often club-shaped, often elastically dehiscent, from the apex downwards, into two recurved boat-shaped halves. Seed rounded or compressed, generally

supported by the indurated funicle, termed retinaculum, often margined with hairs, which are elastic when wetted, without endosperm; embryo large, usually curved.

There are no tree species in the *Acanthaceae*, but a very large number of shrubby and herbaceous species belonging to this family are found in the undergrowth of our forests. Students soon learn to spot a species of this family from the jointed and swollen stems and from the lineolate leaves. These cystoliths are often present in the epidermis of the stem and leaves and appear as raised lines in dry material and often as translucent streaks in the living leaf. The structure of the flowers is remarkably uniform. There are, however, some aberrations. In *Thunbergia*, a climbing genus, the calyx is reduced to a mere rim, its protective function being taken over by the large spathe-like bracteoles. In the subfamily *Acanthoideae* the capsule possesses a special apparatus for jerking out the seeds. The funicle of the ovule becomes hard and hook-like as the capsule matures, and eventually the seed comes to be supported by the structure. The hook is called the ejaculator. When the capsule is mature the two valves open elastically, the halves springing back from apex to base. When this happens the seeds are flung out and disseminated. The seeds are often covered with white elastic hairs which are best seen when wet.

The genus *Strobilanthes* is of interest because many of its species flower periodically, after which the plant dies. One well-known member of this class is *S. wallichii* Nees which flowers every twelve years. It is a common plant in Jaunsar and growing gregariously prevents the establishment of seedlings of the tree species. Troup points out that its mode of growth is peculiar in that each year a new shoot consisting of several internodes is sent up in spring, but at the end of the season the whole of the year's shoot drops off except the lowest internode of the year. The age of the plant, therefore, is the number of old internodes which can be counted.

The genus *Strobilanthes* is best represented in the hill-forests of Madras State, where they are usually gregarious and cover large areas. In such cases they influence the course of natural regeneration. In Burma and Assam the genus is well represented by many species but these never reach the size and luxuriance of their south Indian relatives. The flowers of many species are very beautiful but their value is restricted by the fact that those with the most beautiful flowers do not flower every year. *S. flaccidifolius* Nees is of importance economically, because it contains the indigo dye. It is widely cultivated among the hill-tribes of Assam for this purpose.

Another well-known shrub of the family is *Phlogacanthus*

thyrsiflorus Nees, which is very common indeed in the sal forests of Goalpara, Assam. This shrub is gregarious and where found kills all other vegetation beneath it.

Adhatoda vasica Nees is one of the commonest shrubs of waste places in the northern parts of India. Cattle and sheep will not touch it and it flourishes about villages and over the grazing grounds. It owes its immunity from browsing animals to the fact that it contains some alkaloid distasteful to them. An infusion of the leaves is said to kill mosquitoes, termites and other insects. The leaves are also used as a dressing for rice-fields where they have the power of killing aquatic weeds. It owes its generic name to the Tamil *adhatodai*—‘what goats will not touch’.

One species of this family, *Acanthus ilicifolius* Linn., grows among the mangroves in the tidal mud of the seashore. The leaves are exactly like those of the Holly.

65. GERANIALES

Herbs, shrubs, rarely trees; flowers hypogynous, hermaphrodite, actinomorphic to zygomorphic; ovary syncarpous with axile placentation; stamens as many as to twice as many as the petals; embryo straight; endosperm usually absent.

126. OXALIDACEAE

Herbaceous or shrubby, rarely trees (*Averrhoa*). Leaves alternate, digitately or pinnately compound, exstipulate. Flowers actinomorphic, hermaphrodite, arranged in axillary or terminal panicles or even solitary. Sepals five, imbricate, connate at the base. Petals five, free or connate slightly at the base, contorted, shortly clawed. Stamens ten, united at the base, sometimes five without anthers and shorter, or ten or more antheriferous; anthers 2-locular, opening lengthwise. Ovary 5-lobed, 5-locular; ovules numerous in each loculus. Fruit fleshy, ellipsoid, with five prominent ridges, or a capsule. Seeds with a copious endosperm.

The well-known fruit tree, *Kamranga*, *Averrhoa carambola* Linn., is a species of this family, the remainder of which are almost all herbs or small shrubs. The fruit is extremely good for tarts, especially that of the sweeter varieties, but usually a good deal of sugar has to be added. The juice of this fruit takes stains out of linen and it is sometimes used by washermen for this purpose. Another species, *A. bilimbi* Linn., a native of Malaya, is occasionally planted. It can be distinguished from the former by the more numerous narrowly oblong leaves and the fruit with rounded angles, those of *A. carambola* being sharply angled.

66. BORAGINALES

Herbs, shrubs or small trees ; corolla gamopetalous ; flowers actinomorphic, hermaphrodite ; ovary superior, entire, bicarpellate, often deeply lobed with gynobasic style ; stamens the same number as and alternate with the corolla-lobes ; embryo straight or curved ; endosperm present or absent.

127. BORAGINACEAE

Mainly herbs, some shrubs or even small trees, often scabrid or hispid with broad-based prickles. Leaves alternate, exstipulate. Inflorescence cymose, often scorpioid, occasionally cincinni. Flowers actinomorphic, hermaphrodite. Calyx-lobes imbricate. Corolla often showy, with contorted or imbricate lobes. Stamens the same number as the corolla-lobes and alternating with them; anther 2-locular, opening by longitudinal slits. Ovary 2-locular or 4-locular, entire or deeply 4-lobed, style gynobasic; ovules paired. Fruit of four nutlets. Seeds with or without endosperm; embryo curved or straight.

The only genus in this family which is likely to trouble forest officers is the genus *Tournefortia* Linn. This genus contains a number of shrubs and also a small tree, *T. argentea* Linn. f., which is found on the sea-coast of the Andamans. It reaches a height of 20 ft. and has a dark-coloured, rough bark. The light-green fleshy obovate leaves are collected at the ends of the branches, seated on stout petioles. It is said to be an extremely handsome tree. Parkinson says it is usually associated with *Pemphis acidula* Forst. and *Sophora tomentosa* Linn.

67. L A M I A L E S

Shrubby or herbaceous ; corolla gamopetalous ; flowers hermaphrodite, zygomorphic ; ovary superior, very deeply lobed, with gynobasic style ; ovules four in each ovary ; stamens epipetalous, four or two ; embryo straight ; endosperm very scanty or absent.

128. LABIATAE

Herbs, undershrubs, rarely shrubs, with 4-angled or 4-sided stems. Leaves opposite and decussate or sometimes whorled, simple, aromatic when crushed and often with translucent dots. Flowers hermaphrodite, zygomorphic, often 2-lipped, arranged in contracted cymes in the axils of the leaves or in dense terminal spikes. Calyx tubular, 4-5-lobed or -toothed, persistent. Corolla tubular, 4-5-lobed; lobes imbricate, forming two lips or only one lip. Stamens four or two on the corolla-tube; anther-loculi sometimes confluent or widely divergent, opening

lengthwise by slits. Ovary free, 4-lobed or 4-partite, consisting of two, 2-locular and -lobed carpels; the gynobasic style arises from the inner base of the lobes. Ovule one in each loculus, erect, anatropous. Fruit of four achenes. Seeds with or without endosperm.

A very large family of herbaceous or occasionally shrubby species which students early get to recognize because of their aromatic leaves and 4-lobed ovary with a gynobasic style, and which, for this reason, they are not likely to get in examinations. It is, however, important to be able to spot this family, because, even though they are of no practical use to the forester, they do form a very large part of the herbaceous flora of the forests and must play a considerable part in the synecology of the vegetation. *Colebrookea oppositifolia* Smith reaches the size of a small tree and has a very wide distribution all along the Himalayas to Assam and on into the Burma hills. Its corolla is white or red and the species is used as a hedge-plant in the Khasi Hills.

Leucosceptrum canum Smith is also a small tree with curious maize-cob-like inflorescences, which is found in the hill-forests of the eastern Himalayas, Khasi and Naga Hills and Burma. The leaves are covered with a white felt.

SUBPHYLUM II

MONOCOTYLEDONES

Embryo with one cotyledon, almost always sunk in a copious endosperm, occasionally without endosperm. Herbaceous with some trees. Stem with closed vascular bundles and rarely exhibiting secondary thickness. Leaves almost always parallel-veined, sometimes tessellate. Flowers frequently with trimerous whorls.

CLASSIFICATION OF THE MONOCOTYLEDONS

APART from a few families the Monocotyledons will have little interest for the forest officer. Unfortunately, however, two families, which are of more importance to the human race than any other, belong to this subphylum. These two families are *Palmaceae* and *Gramineae*, and therefore something must be known of their characteristics and of those few others which are woody and are to be found within the forests.

Regarding the classification nothing much need be said, but the student is recommended to read J. Hutchinson's *Families of Flowering Plants*,¹ vol. II. Perhaps the most daring departure from previous orthodoxy is his treatment of *Liliaceae* and *Amaryllidaceae*. It had been considered for many years that the position of the ovary, whether superior or inferior, was the all-important character in the delimitation of these families. In this work the character of the inflorescence is taken to be far more important. In the *Liliaceae*, as now composed, the inflorescence is never truly umbellate, while in the *Amaryllidaceae* the inflorescence is always umbellate. This rearrangement has resulted in more homogeneous groups and in the grouping of genera which are obviously closely related.

68. ZINGIBERALES

Herbs with rhizomes and fibrous or tuberous roots ; stems often formed of the imbricate bases of the sheathing petioles ; leaves spirally arranged or distichous ; calyx and corolla in separate whorls ; ovary inferior ; stamens 5-6, or reduced to one ; embryo small ; endosperm copious.

¹ Macmillan & Co. Ltd.

129. MUSACEAE

This family contains the one genus *Musa*, the Banana, which is well known to everybody in India. The stems are actually formed by the imbricate bases of the petioles. The enormous leaves are spirally arranged and possess a very large midrib and very numerous parallel nerves which extend from the midrib to the margin. The flowers are usually unisexual, subtended by large green, rose or purple bracts, the males being found in the upper bracts and the females within the lower, i.e. the males are near the tip of the pendulous axis of the inflorescence. The sepals and two of the petals connate into a tube, posterior petal free and much shorter than the others. Fertile stamens five, very rarely six, the posterior usually replaced by a staminode; anthers linear, 2-locular. Style free or 3-6-lobed. Ovules 1 - many in each loculus or ovules more or less suppressed in the cultivated varieties. Fruit baccate, crowned with the remains of the flower.

A number of wild species are to be found all over India, often in recesses in the hills and in the secondary vegetation that springs up on abandoned cultivation in the hills. The fibre of *M. textilis* from the Philippines is Manila Hemp, the strongest of all cordages.

The Traveller's tree, *Ravenala madagascariensis* Gmel., is usually included under *Musaceae* and is one of the more striking introductions into gardens. The leaves are in one plane and spread out erect like a peacock's tail. The resemblance of the leaves to those of the banana will, almost certainly, lead to its identification. This striking plant is called the Traveller's tree because of the clear potable water which gathers in the cups formed by the petiole bases.

130. ZINGIBERACEAE

A family of perennial herbs generally with fleshy rhizomes. The stems usually composed of leaf sheaths only, sometimes developed, leafy. Leaves in two rows, usually with a ligule. Inflorescence various, sometimes of solitary flowers, sometimes spicate. Flowers moderate-sized or large, often beautifully coloured. Calyx more or less tubular or spathaceous, generally shortly 3-toothed, often colourless. Corolla usually on an elongate quasi-hypanthium, bearing the three petals and the androecium. Stamen only one perfect, being the dorsal one of an inner whorl, of which the two anterior members are combined into a petaloid lip with its hinder margins embracing the fertile stamen. In addition there are two lateral staminodes present. Connective of fertile stamen often produced or appendaged. Ovary 3-locular with axile placentation or 1-locular

with three parietal placentas. Style long and delicate, often in a groove with stamen. Ovules many. Fruit usually capsular, sometimes indehiscent and breaking up irregularly (*Alpinia*).

The family contains a number of striking, and often aromatic, herbs which are found in the forests of India. These plants are indirectly the concern of the forest officer in that a large number of minor forest-products are obtained from them. Turmeric, Arrowroot, Ginger and Zedoary are all obtained from species of *Curcuma*. Cardamoms also are produced by this family. An excellent paper can be obtained from a species of *Hedychium*, while in Assam and Bengal the departmental elephants love the succulent aromatic *Alpinia allughas*. The herb *Costus speciosus*, a common plant in the sal forests, is recognized by its large white corollas and spirally arranged leaves.

The peculiar shape of the zygomorphic flower, its frequently bright colours and particularly the single stamen are responsible for members of this family being often mistaken for orchids. Such misidentification is, of course, only due to superficial and careless examination, but the mistake is constant among students and, sad to relate, among those who ought to know better. In *Zingiberaceae* the inner whorl of perianthlobes is regular, in the *Orchidaceae*, irregular.

69. LILIALES

Herbs with rhizomes, corms or bulbs ; stems leafy or leaves reduced to cladodes ; flowers small to large and showy, usually hermaphrodite, actinomorphic ; ovary superior or semi-inferior, 3-locular with axile placentas ; embryo curved or straight ; endosperm copious.

131. LILIACEAE 132. SMILACACEAE
133. RUSCACEAE

131. LILIACEAE

Perennial herbs, rarely soft-wooded shrubs; rhizomes, corms, bulbs or tubers present; stem erect or climbing. Flowers hermaphrodite, actinomorphic. Inflorescence various, never an umbel. Corolla mostly corolla-like, with or without a tube; lobes usually six, usually in two distinct series of three each; imbricate or the outer valvate. Stamens six, hypogynous or adnate and opposite to the perianth lobes; anthers 2-locular, opening by longitudinal slits. Ovary superior, 3-locular with axile placentas; ovules numerous. Fruit a loculicidal or septicial capsule or a fleshy berry. Seeds with copious endosperm.

This large family, with its numerous showy garden-plants, has also a few soft-wooded species which are found in the forest.

Perhaps the commonest of them all is the genus *Asparagus*, easily recognized by the cladode-like feathery foliage. These prickly shrubs are very common in the drier type of forest. They usually first bring themselves to the victim's notice after having lacerated his knees with their sharp, straight or recurved thorns. Anyone whose acquaintance with the genus is confined to the contents of the American can, will have to readjust his ideas. The feathery delicate shrubs appear to have little in common with the succulent contents of the tin. The latter is the fleshy tip of the current year's shoot, severed as it reaches the desired length above the soil.

The following is a key to the commoner species (after Parker).

Flowers solitary or in small clusters; cladodes in tufts of 2-8,
straight ... *A. gracilis*

Flowers in racemes:

Cladodes 0.5 in. long or more:

Cladodes in tufts of 2-6; spines usually recurved

A. racemosus

Cladodes in tufts of 6-20; spines usually straight

A. adscendens

Cladodes 0.15-0.25 in. long

... *A. curillus*

Gloriosa superba Linn., a very beautiful scrambler, is found wild in many parts of India but its beautiful flowers are an addition to any garden. One half of the undulate curved petals is red, the other half orange, and the handsome leaves end in a cirrhose tendril which is used in climbing.

Eremurus himalaicus Baker, with its dense terminal raceme of pale-yellow flowers, is a striking herb of the inner dry Himalayan valleys, where it grows gregariously.

132. SMILACACEAE

Climbing shrubs; leaves alternate, rarely opposite, 3-5-nerved and reticulate; petiole sheathed and with two tendrils from the top of the sheath. Flowers small, actinomorphic, dioecious, arranged in subaxillary umbels, racemes or spikes. Perianth segments six, incurved or recurved. Male flowers, stamens six or more at the base of the perianth, free; anthers 1-locular, opening by a longitudinal slit, introrse, pistillode absent. Female flowers; ovary 3-locular, 3-angled; ovules 1-2 in each loculus, pendulous; style none or short; stigmas three, stout. Fruit a globose berry.

A genus with a large number of species, which can be easily recognized in the forest from the leaves. These are 3-5-nerved at the base, reticulate, and vary in shape from oblong to nearly orbicular. The plants climb by means of their twisted petiole and also by means of the two cirrhi from the top of the leaf-sheath. These prickly climbers are a menace to those who

wear shorts in the forest. They do a lot of damage in sal plantations.

133. RUSCACEAE

Stems woody. Leaves alternate, reduced to small scarious scales bearing in their axiles elliptic, coriaceous phyllocladia. Flowers small, fasciculate, dioecious, arranged in umbels seated on the midrib of the phylloclade. Perianth segments six. Stamens six in the male flowers, absent in the female flowers. Ovary 3- or 1-locular; ovules two in each loculus, collateral. Fruit a globose berry. Embryo small. Endosperm copious.

Ruscus hypophyllum Linn. draws attention to itself by the position of the umbel of flowers on the midrib of the phylloclade. It is a very small woody shrub which is not indigenous to India but is often cultivated in gardens in the plains. Examiners have for long regarded this plant with favour as, with its aid, students who are shaky on their morphology can be easily 'caught out'. Compare the position of the inflorescence of *Helwingia* (Cornaceae).

70. AGAVALES

Perennials with a thick woody caudex or rhizome; stem often woody; flowers hermaphrodite to dioecious, actinomorphic; ovary superior or inferior, 3-locular; ovules on axile placentas; stamens six; embryo small; endosperm copious.

134. AGAVACEAE

This family, which contains many beautiful garden-plants, is included here because there are some genera and species which are of some importance economically.

The interesting species can be separated by means of the following key.

Perianth-segments free	...	<i>Yucca</i>
Perianth-segments united at base:		
Ovules numerous	...	<i>Cordyline</i>
Ovules solitary:		
Stem present, woody	...	<i>Dracaena</i>
Stem absent	...	<i>Sansevieria</i>

Yucca Linn. This is an American genus, but it has been introduced into India and is often met with. The species are acaulescent or have a distinct trunk. The flowers, which are themselves pendant, are produced in large erect panicles. The white flowers open at night and have a somewhat mawkish sweet odour. It is worth while mentioning that these flowers are pollinated by a small moth, *Pronuba yuccasella*. The

larvae of the moth live upon the developing seeds and to ensure that there will be developing seeds the moth deliberately takes pollen and thrusts it into the stigmatic chamber. As the larvae feed exclusively on the developing seeds of *Yucca* and will die without them, it will be realized that here we have a very remarkable adaptation of plant and insect to one another. *Y. filamentosa* Linn., also known as Adam's Needle, so named because of the filamentous threads on the margins of the leaves, is to be found in botanical and private gardens. *Y. aloifolia* Linn. has a slender trunk and with the panicle can reach 15 ft. in height.

Cordyline terminalis is a moderate-sized shrub with distichous green or purplish leaves and small pretty rose or white flowers, which is widely cultivated in gardens in India. It is often found as an escape.

Dracaena Linn. A number of beautiful species of this genus are cultivated for their very handsome leaves which are often brightly coloured on one surface. A few species are wild in India, Burma and the Andamans. *D. angustifolia* Roxb. reaches 20 ft. in height. *D. spicata* Roxb. is smaller, and both these species range from Assam to the Andamans.

These and other species are the source of a red resin which is known as Dragon's Blood.

Sansevieria Thunb. *S. roxburghiana* Schult., the Bowstring Hemp, is occasionally to be found in Madras State.

71. PALMALES

Acaulescent to very tall and woody, sometimes climbing; flowers small, actinomorphic, hermaphrodite to dioecious; perianth of two trimerous whorls; ovary superior, 1-3-locular; ovules solitary; stamens usually six, in two series; embryo small; endosperm copious.

135. PALMACEAE

This family contains upwards of 170 genera and probably more than 1500 species. They are for the most part tropical in distribution but there are a few which are found in temperate regions. For example *Chamaerops humilis* is a native of the Mediterranean region, while the date palm yields fruit as far north as 35°N. Broadly speaking, however, the palms are to be found in the tropics in all lands of both worlds, but the old world and the new world forms are usually distinct. It has been found, however, that the new world forms do exceedingly well when transported to areas in the old world with a similar climate, and African palms do as well in India as in their own home. This is a very important point in view of the fact that the palms have such a great economic value.

Within this family the species exhibit more contrasting vegetative characters than any other family of flowering plants. Here we find stemless plants in contrast to those with stems up to 500 ft. long; fruits as small as peas to the largest single fruit in the vegetable kingdom; leaves 50 ft. long by 8 ft. wide down to mere insignificant blades 1 to 2 ft. long by a few inches wide; stems as thin as reeds to those over 5 ft. in diameter. Apart from all this, however, this family, with the exclusion of the *Gramineae*, is of more value to the human race than any other.

Nothing much need be said about the flowers, which are inconspicuous in themselves and often sunk in the branches of the inflorescence, thus forming simple or branched spikes. The flowers are white, pale-yellow or even green in colour, but as if to make up for their insignificant show they are produced in such profusion as to make the inflorescence a very striking object indeed. The inflorescence is at first protected in a spathe, an organ which is of importance in the diagnosis of species.

The flowers are hermaphrodite, monoecious, or dioecious or even polygamous and consist of two trimerous whorls—the outer, the sepals, are separate or connate, imbricate or open in the bud; the innermost whorl, the petals, are connate or free, usually valvate in the male, imbricate in the female flowers. The stamens are usually only six, but there may be many. The ovary is superior, rudimentary or absent in the male flowers, and usually consists of three carpels which are free or connate at the base. The ovules are usually solitary, rarely collateral, attached to the central angle just above the base, sometimes orthotropous with the micropyle superior or sometimes almost anatropous with the micropyle inferior. The fruit is a berry or drupe, 1- to 2-locular, or the fruiting carpels may be distinct. The exocarp is fibrous or is often covered with reflexed scales. The seeds are free or adherent to the endocarp. The small embryo is sunk in the copious endosperm, which is sometimes ruminate.

A characteristic of the inflorescence is the enormous quantity of pollen which is produced. It has been estimated that a mature coconut tree produced something in the neighbourhood of 400,000,000 pollen-grains every year. The soil below date and coconut palms is often yellow from the quantity of pollen poured out by the inflorescence.

The very great majority of species flower and fruit every year, but some genera, e.g. *Corypha*, *Plectocomia*, *Plectocomiopsis*, *Metroxylon*, spend their whole life in preparation for the supreme act of flowering and fruiting. After many years' growth the Talipot, *Corypha umbraculifera*, develops a gigantic terminal bud about 4 ft. high. In due course this bud

bursts with a loud report and releases a majestic and colossal panicle of cream coloured flowers which reaches a height of 20 ft. above the tip of the stem. After the fruit is formed the stem dies.

The adult palm generally has a tall woody stem, bearing a crown of leaves. Sometimes, however, the stem is almost non-existent but it is doubtful if there is any palm in which the stem is entirely absent. In others the stems are very long and thin and are carried over other vegetation, which is used as a support, until they reach a length of 500 ft. or more (*Calamus*).

The trunk of some species is quite smooth, with circular scars where the leaf-bases have dropped away, in others the trunk is covered with a woven fibrous or hairy covering which binds together the leaf-bases of fallen leaves. Others again are beset with cylindrical or flat-branched spines, 8-10 in. long and as sharp as needles. These spines lie flat against the stem until the leaves drop off. Branching of the stem is most exceptional but it regularly occurs in the genus *Hyphaene*, where the branching is true dichotomy. Abnormal branching is sometimes found in other genera but this can almost always be ascribed to an injury to the terminal bud.

The leaves are, apart from certain inflorescences, the most striking feature of the palms. The largest surpass in size those of any other kind of plants. There are two types of leaves—the palmate and the pinnate—each with a petiole which, in the case of the fan-palms, has a ligule next the trunk. In many palms the leaves are clustered at the apex of the trunk but in the climbing species the pinnate leaves are borne equally spaced along the stem. In some of the climbing palms, or rattans, the rachis of the leaf is produced into a flagellum which is armed with formidable recurved prickles. These spines and prickles aid the plant in climbing.

The Monocotyledons as a class are without secondary thickening and the plant-body consists of primary tissue only. Vestiges of cambial activity occur, however, in a few genera, especially in the nodal region at the leaf-bases. A special type of thickening occurs (similar to that in *Dracaena*, *Aloe*, *Yucca*, etc.) in a few forms where the diameter of the stem is increased by the formation of a cylinder of new bundles embedded in a tissue of less specialized nature. This is particularly noticeable, for example, in the stem of *Oreodoxa regia*,¹ which is not a perfect cylinder but swollen at base and apex. In this species a cambial layer is formed from the meristematic parenchyma of the pericycle or of the innermost cortical cells. This cambium does not, however, produce phloem on the outside and xylem

¹ Now known as *Roystonea regia* O. F. Cook.

on the inside in the normal way, but forms amphivasal or collateral bundles on the inside scattered in parenchymatous ground tissue. The outer tissues are parenchymatous and limited in amount or even absent.

The thickening which takes place at the bases of some palms is not due to the activity of a definite cambium layer, but is due rather to the gradual increase in size of the cells and intercellular spaces, and—in rare cases—to the proliferation of strands of tissue to form new fibres. Thickening therefore is in general a long-delayed continuation of primary growth. Usually no new vascular tissue is formed in the thickening of palm-stems. In palms the embryonic stem remains very short on germination. The primary meristem of the flattened growing point, leading to the axis of the seedling, from which the columnar stem emerges, has a considerable thickness from an early age.

The course of the vascular bundles in the stem is complex. The individual bundles of the leaf-traces penetrate to different depths in the stem and appear scattered in cross-section. This results from the prolonged growth in thickness of the growing point after the procambial strand of the first and medial bundle of the leaf is laid down. In palms the leaf-base completely encircles the stem and therefore at each node numerous bundles pass into the stem all round its circumference. The central bundle penetrates to the centre of the stem, and the lateral bundles penetrate less and less deeply in proportion to their distance from the median bundle. In their downward course the bundles approach the periphery of the stem, where they fuse with the others. It follows that the hardest part of the stem is near the outside of the trunk which consists of closely packed woody bundles and fibres. Near the centre the tissue is softer, and consequently becomes hollow in old stems.

When the fruit ripens two of the carpels with their ovules may become abortive—as, for example, in the coconut, where we find only one seed, though the three carpels are distinctly indicated by the three longitudinal sutures and by the constant presence of three round scars (germ pores) on the hard endocarp. The fruit of the palm is either a berry or a drupe, and in the latter the endocarp is united to the seed.

The fruit of one section, which includes the canes, sago palms etc., is covered with closely fitting, generally smooth, imbricating scales.

The fruits vary in size from small to very large. Some are as small as peas, while the giant of them all is the fruit of *Lodoicea*, the double coconut, about 4 ft. in circumference and 25 lb. in weight, which is probably the largest single fruit in the vegetable kingdom.

The point on the testa of a seed, from which well-marked vascular bundles radiate, shows the position of the raphe or chalaza. The inner integument of the ovule is in some genera much thickened along the course of these bundles, and becoming greatly increased in size during ripening, grows into the endosperm and produces the characteristic appearance in section known as ruminant (e.g. betel-nut, *Areca catechu*). Within the thin fibrous seed-coat there is a copious endosperm which holds, embedded in some part of its circumference, a minute cylindrical or conical embryo.

The endosperm may be comparatively soft containing much oil and proteid (coconut), or it may be hard (date) or occasionally mucilaginous.

The coconut may be taken as a general example of germination. The well-known nut of this palm is covered with a fibrous husk which is not usually seen outside its home but which is the source of coir, a fibre which is extensively used in industry. The interior of the nut is lined with albumen, and the central cavity is half filled with a watery fluid which is very good to drink. As the nut ripens the watery fluid becomes reduced in volume and finally becomes quite white. The albumen turns hard and white. On germination a special absorbing organ is developed as an extension of the cotyledon on the inner end of the embryo. From the outer end of the embryo the plumule and roots push through one of the germ pores. The cotyledon, or rather the specialized portion, attacks the white meat and continues to grow until it completely fills the shell. The roots push out and enter the soil before the endosperm is completely absorbed. The young plant begins to grow and finally the connexion between it and the nut is severed. The first leaves are simple and the characteristic foliage is only developed after several years.

A whole book or a series of volumes could easily be written on the valuable products yielded to humanity by this group of plants. Second only to the *Gramineae* the palms offer a wealth of economic products without which it would be difficult to imagine life as we know it today. Some of us have writhed under what Charles Dickens called 'a terrible instrument of flagellation, strong, supple, waxed at the end', constructed from the stem of a slender rattan, whose advantages for this purpose lie in its flexibility combined with strength which enable it to follow closely those contours provided by Nature for corporal punishment. We wipe our boots on a coir mat (the husk of the coconut). Walking-sticks and furniture are made from cane. Brooms are also made of palm vascular bundles. Rope, cordage of all kinds and even cloth can be obtained from palms. The fibrovascular bundles found in the petioles of the leaves, in the flowering stalks and also in the

stems are made into brushes and brooms. Of foods, the date, oils, fats, sugars, sago, starch etc., are all obtained from palms. The terminal bud makes an excellent vegetable (it may be mentioned in passing that this mutilation sometimes causes the stem to bifurcate). Strong and durable house-posts can be obtained from the trunks.

Toddy and sugar can be obtained from palms. Before the flowers open a sugary sap flows in large quantities towards the spadix. The inhabitants of the tropics have learned how to tap this sap which, on fermentation, becomes the tippie known as toddy, and the operation was carried out on a colossal scale. The unfermented juice yields sugar on evaporation. In India *Phoenix sylvestris* was regularly tapped for its sap. In this species the crown leaves grow erect, while the lateral leaves just below the top spread out horizontally. After the rainy season these lateral leaves were cleared from half the trunk. On the cleared surface a V-shaped incision was made and the dripping sap caught in a small earthenware vessel. The process was continued after suitable intervals until the following hot weather. One tree yielded about 80 lb. of sugar in a season, which, of course, if fermented, gave many gallons of toddy.

The date palm, *Phoenix dactylifera*, also yields toddy and sugar. Here the treatment is more drastic in that the terminal bud is cut off and the sap collected in the hollow so formed. Three to four quarts can be collected daily from each tree for about six weeks, after which the palm is exhausted. The sap can be fermented and yields arrack—the most intoxicating liquor in eastern countries.

The Palmyra palm (*Borassus flabellifer*) is also tapped. In this instance it is the root of the spadix which is attacked, and it also delivers three to four quarts of sap in a day. Sugar and toddy are obtained from the sap.

The genus *Metroxylon*, an American genus, gives the best sago, but several other palms yield a sago not to be despised—that is, if anyone can acquire a liking for this substance. One such tree is *Caryota urens*. It will be remembered that *Metroxylon* is one of the genera which flower only once and then die. Just before flowering time the trunk is felled and split open and the soft interior is scraped out and thrown into water. The starch, purified after several washings in water, comes away. A tree fifteen years old will yield as much as 800 lb. of sago. This enormous quantity of starch is apparently used up in the production of the spadix, flowers and seeds, for, if the trunk be felled after flowering, no starch is to be found.

It is obviously quite impossible to give a key to the species of this family found in the forests of India and Burma even if

all the species were known. Parker¹ and Blatter² give a great deal of information about these interesting plants.

The following is a key to the wild genera in India.³

Leaves flabelliform:

Petiole unarmed:

Blade divided into 5-7 nearly free segments 1. *Rhapis*

Blade not so deeply cut, with many more segments:

Petiole prolonged into the blade 2. *Sabal*

Petiole not prolonged into the blade:

Tufted; stems prostrate or underground

3. *Nannorrhops*

Single-stemmed; trees ...

4. *Trachycarpus*

Petiole armed:

Leaves 6-8 ft. in diameter:

Leaf margins with long loose fibres

5. *Washingtonia*

Leaf margins without such fibres:

Fruit 6 in. in diameter ...

6. *Borassus*

Fruit much smaller:

Leaflets connate in lower third

7. *Chamaerops*

Leaflets connate to the middle

8. *Livistona*

Leaflets entirely separate

9. *Licuala*

Leaves 8-16 ft. in diameter ...

10. *Corypha*

Leaves pinnate:

Leaves bipinnate ...

11. *Caryota*

Leaves simply pinnate:

Lower leaflets spinescent

12. *Phoenix*

Lower leaflets not spinescent:

Inflorescence on the stem:

Very tall trees (100 ft.):

Cultivated in India ...

13. *Areca*

Not cultivated; Nicobars

14. *Ptychoraphis*

Up to 50 ft. tall; usually much less:

Spathes only one ...

15. *Pinanga*

Spathes more than one ...

16. *Bentinckia*

Inflorescence among the leaf bases:

Erect shrubs or trees:

In tidal forests, stemless ...

17. *Nipa*

Not in tidal forests, with stems:

Leaflets acute ...

18. *Cocos*

Leaflets praemorse ...

19. *Arenga*

Climbing shrubs:

Monocarpic palms:

Spadix with long amentiform branches clothed

¹ In *A Forest Flora for the Punjab*.

² In *The Palms of British India and Ceylon*, Oxford University Press.

³ Compiled from Parker, Blatter and Brandis.

with large closely imbricate spathels

20. *Plectocomia*
Spadix much-branched; the branches with
small infundibular spathels

21. *Plectocomiopsis*
Polycarpic palms ... 22. *Calamus*

1. *Rhapis* Linn. f. *R. flabelliformis* Ait. is a tufted rattan, indigenous to China, but very commonly cultivated in India. Excellent walking-sticks can be obtained from the stems.

2. *Sabal* Adans. Species of this genus are the Palmetto palms. Two species are cultivated in India, the Dwarf, *S. adansonii* Guers., and the Cabbage tree, *S. palmetto* Lodd. In the U.S.A. the terminal bud is stripped from the young trees and a fibre is obtained from it.

3. *Nannorhops* H. Wendl. *N. ritchieana* H. Wendl. is a low tufted gregarious shrub common in the very arid regions of the Indian Peninsula, in Sind and the Punjab, in Baluchistan and Afghanistan. As might be expected it is of very great value to the inhabitants of these treeless, inhospitable areas as it serves as food, source of fibre, fuel, and has many other uses.

4. *Trachycarpus* H. Wendl. *T. martiana* H. Wendl. is a magnificent palm found in the neighbourhood of 6,000 ft. in the Himalayas, Naga Hills, Manipur and in the hill-districts of Burma. It is usually to be found growing gregariously.

5. *Washingtonia* H. Wendl. *W. filifera* H. Wendl. is a palm, 60-70 ft. tall, which is indigenous to the southern U.S.A. It has long been cultivated at Saharanpur in Uttar Pradesh.

6. *Borassus* Linn. *B. flabellifer* Linn. is the well-known Palmyra palm of India and Ceylon. In one way or another every part of this palm is put to some use. Vast quantities of toddy used to be drawn from these trees in the cold-weather months just as the spathes begin to be formed. It is the juice that flows towards the inflorescence which gives the sugary fluid made into toddy. Jaggery and vinegar can be obtained from the toddy. Arrack is the product resulting from the distillation of toddy. The fruit gives a food, and fibre and cordage can be obtained from many parts of the plant.

7. *Chamaerops* Linn. *C. humilis* Linn. is the only palm indigenous to Europe. It is sometimes cultivated in India.

8. *Livistona* R. Br. One species, *L. jenkinsiana* Griff., is indigenous to India and Burma, and several others have been introduced from Malaya. The indigenous palm is found in great abundance in Assam and also in Burma. The leaves are greatly valued in Assam for their lightness, toughness and durability. After being soaked in water they are used for roofing houses, boats and sheds. They are also made into rain-hats.

9. *Licuala* Thunb. The genus of fan-palms is easily recognized

by the broad wedge-shaped leaflets being free to the base. *L. peltata* Roxb. is found in the hot valleys of lower Sikkim and also in the Khasi and Naga Hills in similar situations. It penetrates into Burma and is also found in the Andamans. The leaflets are widely used for thatching, being stripped off the petioles and stitched or fastened to slivers of bamboo. In the Andamans another species is found, *L. spinosa* Wurmbr., which is smaller in all its parts. It occurs in the outskirts of the mangrove forests and is often to be found growing gregariously.

10. *Corypha* Linn. The Talipot, *C. umbraculifera* Linn., is a large palm with an annulate trunk reaching 80 ft. in height and found wild in Madras State, Ceylon and in the Andamans. It is extensively planted elsewhere. This is a monocarpic palm, i.e. which flowers and fruits only once in its lifetime. The inflorescence is of surpassing beauty, being quite 20 ft. tall and containing, at a conservative estimate, half a million cream-coloured flowers. As with most palms many uses are found for the various parts. The leaves are made into umbrellas and also serve as paper for the preservation of ancient records. The pith is eaten. The hard seeds can be made into beads, and fibres can be produced from the leaves.

11. *Caryota* Linn. A very easy genus to recognize from its bipinnate leaves. There are three species in India. One, *C. urens* Linn., grows all over India, *C. obtusa* Griff. grows in the Mishmi Hills and *C. mitis* Lour. grows in Burma, in the Andamans, and also in Malaya. *C. urens* Linn. is the source of the well-known *Kittul* or *Salopa* fibre, which is much in demand for brush-making. The pith of the trunk is said to be equal to the best sago on the market. The tree has been used to produce a toddy. The terminal bud is edible and the timber is also used, as it is very durable.

12. *Phoenix* Linn. A number of species are found in India. The following is a key to them.

Inland species:

Tall palms 15-20 ft. high:

Stem covered with the persistent leaf-bases:

No root-suckers; crown dense, hemispherical

P. sylvestris

Root-suckers copious; crown open

P. dactylifera

Stem tessellated with small spirally arranged sheath-scars

P. robusta

Low palms; stems almost absent or up to 12 ft. tall:

Leaflets bifarious:

Stem 1-12 ft. tall; fruiting peduncle 2-4 ft. long

P. humilis

Stem ovoid, like a bulb; fruiting peduncle short

P. acaulis

Leaflets 4-farious	...	<i>P. pusilla</i>
Littoral species	...	<i>P. paludosa</i>

P. sylvestris Roxb., the Wild Date Palm, is common throughout India and Burma, wild or cultivated. The tree is of considerable importance in eastern India owing to the fact that much sugar is obtained by tapping the sap. The *Gur*, as it is called, is produced in enormous quantities and is an important addition to the available food. As is true of nearly all the palms valuable fibres can be obtained from the leaves and leaf-stalks. The wood gives a durable post or beam. The stem of this palm is covered with the persistent leaf-bases, and is very rough. It is often found to be supporting an astonishing number of other species, Dicotyledons and Monocotyledons, the seeds of which have been blown or fallen into the crevices on the stem. Sooner or later the seeds of a strangling fig germinate in these crevices and a common sight in India is the leaves of a *Phoenix* growing out from the stem of a *Ficus*. Branching of the stem has been reported and is obviously due to injury to the terminal bud.

P. dactylifera Linn., the Date Palm, is cultivated in Sind and in the Punjab and isolated specimens will be found in other parts of India, but it is essentially a palm which revels in extremes of temperature and in arid rainless areas provided it can get a certain amount of moisture in the soil. Apart from the fruit, toddy and sugar, the date palm is to the inhabitants of Arabia, Egypt etc., what the bamboo is to the villager of India. The fruit in India is never equal to that obtained in Egypt or Arabia.

P. robusta Hook. f. is a palm which is found in Madras State and on Mt Parasnath in Bihar. The trunk appears tessellated from the spirally arranged sheaths of fallen leaves and it is hardly likely to be mistaken for anything else.

P. humilis Royle is found in the hilly districts of India and Burma. The short stem of this palm and its hilly habitat are sufficient to separate it from the others.

P. acaulis Roxb. is an almost stemless species, and therefore unmistakable, found in the plains and hills of northern India, in Burma, Madhya Pradesh and in North Kanara. It is found in the grassy uplands of the Naga Hills where the vegetation is often *Pinus insularis*. It is also associated with *P. roxburghii* and *Shorea robusta* in north India. The terminal bud makes an excellent vegetable.

P. pusilla Gaertn. (*P. farinifera* Roxb.), a bushy species found in Madras State and in Ceylon. The pulp of the seeds is eaten, the trunk contains a sago and various parts of the plant yield a fibre.

P. paludosa Roxb. This palm is one of the species of the mangrove swamps of Bengal, the Andamans and Burma. It yields a fibre and the smaller stems are often made into walking-sticks. Snakes are said to flee at the approach of anyone who carries such a stick.

13. *Areca* Linn. A genus of palms of which there are four indigenous species in India. One of these, *A. catechu* Linn., is a tall graceful palm, much cultivated for the sake of its fruit, the betel-nut. The nut is chewed with the leaf of *Piper betel*, the Pan, and lime, and is the origin of the splashes of dark-red which decorate the streets of many Indian cities. The powdered nuts are much used as a vermifuge for animals. The other three species are low palms, one found in the Naga Hills, another in Ceylon, and the third in the Andamans and Burma.

14. *Ptychoraphis* Becc. *P. augusta* Becc. is a tall slender palm found in the Nicobars.

15. *Pinanga* Blume. A genus of rather low palms, of which there are about eight species in India and Burma. They are all annulate, stemmed species with pinnate leaflets the upper leaves of which are confluent. They are found in the damp steamy atmosphere of evergreen forests, often gregarious in swampy localities. The stems are of value for walling.

16. *Bentinckia* Berry. *B. coddapanna* Berry is a slender reed-like palm 20-30 ft. tall with an annulate stem, found wild only in Travancore on precipitous cliffs. *B. nicobarica* Becc., as its name implies, is found in the Nicobars.

17. *Nipa* Wurm. *N. fruticans* Wurm. is found in the tidal swamps of India, Burma, the Andamans and Ceylon where this palm covers enormous areas. The fruit is about 1 ft. in diameter and is a syncarp of many 1-seeded carpels of which the pericarp is fibrous and the endocarp is spongy. Such fruits can float on the sea-water and are disseminated far and wide. The leaves are prized for thatch and the plant itself must be of value for stabilizing soil and acting as a breakwater. Toddy and its concomitants, vinegar and sugar, are obtained by tapping.

18. *Cocos* Linn. *C. nucifera*, the Coconut Palm, is the single indigenous species and is hardly likely to be mistaken for any other palm. Books could be, and actually have been, written upon this palm and its usefulness to man, and many pages could be filled with lists of the useful products obtained from it. Food, drink, oil, toddy, fibres, coir etc. are all obtained from the coconut, and actually every part of the palm is put to some use or other.

19. *Arenga* Labill. There are three species of this palm, of which *A. saccharifera* Labill. is the most important. It is found wild in Assam and Burma and is often cultivated in India. It yields toddy, sugar, and sago. At the base of the petioles is found a beautiful black fibre, exactly like horse-hair, known

as Gomuta fibre, which is very strong and can be used under water.

20. *Plectocomia*, 21. *Plectocomiopsis* and 22. *Calamus*. These genera contain among them the very important group of climbing palms, the stems of which are of such extraordinary value to mankind. Enormous quantities of cane are extracted from the forests each year and a great industry has been built up about these climbing palms. The uses to which canes or rattans are put are very numerous. They are used for tying and binding, for making baskets, fish-traps and all the usual articles of household furniture. Bridges up to 300 ft. long are built of cane in the Mishmi Hills and some of them are real feats of engineering.

72. PANDANALES

Trees and shrubs, sometimes climbing, often with aerial roots ; branching sometimes dichotomous ; leaves cauline, spirally arranged ; flowers very small, dioecious ; perianth rudimentary ; ovary superior, 1-locular, accompanied by staminodes or not ; stamens numerous ; anthers erect, basi-fixed, 2-locular ; loculi opening by slits ; fruit a syncarp ; seeds small ; embryo minute ; endosperm fleshy.

136. PANDANACEAE

Stemless or almost stemless shrubs, climbers or occasionally trees with stilt roots, simple or 2-3-chotomously branched, annulate, cylindric. Leaves strap-shaped, crowded at the end of the branches, 3-4-farious, spirally arranged, usually spinulose on margins and keel. Flowers dioecious, small, crowded on simple or branched spikes which are terminal and in the axils of the upper spathaceous leaves. Perianth absent. Male flowers with numerous stamens with filaments free or connate ; anthers erect, basifixed. Female with staminodes or not ; ovary superior, 1-locular ; ovules anatropous, solitary to many, basal or parietal. Fruit a syncarp consisting of many, angled, 1- several-locular, woody or fleshy drupes. Seeds minute, with endosperm.

There are two genera of this family in India and Burma : *Pandanus* which contains shrubs and trees and *Freycinetia* which consists of climbers only. *Pandanus* Linn. is a genus of a few trees and sprawling shrubs. When trees, the species of *Pandanus* are quite unmistakable with their stilt or aerial roots and dichotomous branching. When the species are shrub-like they are apt to be confused, without much reason, it must be admitted, with species of *Agave*. The fruits, which are somewhat like miniature pineapples, are sufficient to place the plant in its correct genus. The leaves of the tree species are some-

times up to 15 ft. long, armed with fearsome prickles, one line being forwardly directed and the adjoining line backwardly directed. This unpleasant characteristic makes the leaves unattractive to browsing animals. The fruit, seeds and leaves of some species are edible. Fibres can be extracted from the leaves, which can also be woven into mats.

The species of *Freycinetia* are climbers which are of no importance to the forest officer.

73. GRAMINALES

Annuals or perennials, often woody and very tall; stems usually hollow; flowers very small, monoecious, dioecious or hermaphrodite, distichously arranged; ovary superior, 1-locular; ovule one, anatropous, erect; stamens 1-6, hypogynous; fruit a caryopsis, rarely a nut, berry or utricle; embryo small; endosperm copious.

137. GRAMINEAE

Annual or perennial herbs (grasses) or suffruticose, climbing or with large woody culms (bamboos). Stems or culms cylindrical, hollow or solid between the transverse septa at the nodes. Leaves distichous, provided with a sheath. Between the leaf-blade and the sheath will be found a hyaline, hard or membranous appendage, the ligule. Flowers arranged in spikelets, usually hermaphrodite, often unisexual, occasionally dioecious, always much reduced, solitary in the axils of closely imbricating sessile green or scarious or coriaceous lemmas; each floret between the lemma and another scale, the palea; these being supported at the base by a pair of herbaceous or coriaceous empty glumes. Lemmas and glumes distichous and alternate on a minute axis called the rhachilla; each separate system of glumes, lemmas and paleas is called a spikelet. Spikelets arranged in spikes, racemes or panicles. Within the lemmas and palea is the flower consisting of ovary, 1-6, usually three stamens and also two or three fleshy scales called lodicules, whose purpose apparently is to press apart the lemma and palea at anthesis. Ovary 1-locular, 1-ovuled; ovule anatropous. Fruit a caryopsis consisting mainly of endosperm and a small embryo. Sometimes pericarp thick and fleshy and fruit large, in which case the endosperm of the seed is vestigial. Seed-leaf or cotyledon modified as the scutellum, a sucking organ.

A very large family containing about 600 genera and about 10,000 species, which are found wherever vegetation will grow. This group of surpassing interest and difficulty, and of such enormous importance to mankind, has not been studied with that intensity in India which its importance warrants. From the forest officer the *Gramineae* demand attention on several

grounds. They are everywhere in his forests, often becoming gregarious, and either being helpful or harmful to natural regeneration. The demand for grazing in the forests has raised problems for the forest officer, because it is his business to know how species stand up to grazing and what happens to them if over-grazed. This raises problems of ecology which are obviously outside the scope of this book, but it will be agreed that a preliminary to any ecological study is the identity of the plant and, therefore, the forester must know something of the grasses in his forest.

The bamboos, the large woody as opposed to the succulent low species, are important to the forest officer. Some forests, indeed, consist entirely of bamboos and others have these interesting plants as an underwood. The various species require different treatment, and here again the forest officer must know something about the bamboos he is likely to meet with.

There is no easy way to a knowledge of the grasses, and particularly of the bamboos. Identification depends upon an examination of the flowers, and while these are produced every year in the majority of grasses, this is not always so as will be seen later on.

India possesses, including the bamboos, about 1,000 species of grass distributed among about 180 genera. A very large number of these grasses grow away from the forests, either on the coasts or in open country inland or in alpine situations and are not likely to trouble the forest officer. There are one or two species of non-bamboo grasses which every forest officer must know, and which almost every Indian will know at least by their local names.

The first of these is the Thatch grass, *Imperata cylindrica*, which exists all over India in the plains and well up into the hills, adapting itself to a very wide range of soils. A most instructive pamphlet on this grass has been written and should be consulted.¹ This grass is of importance in sal regeneration areas. When grazed it subsides as a depauperate species scarcely a few inches high. When burned and in moderate shade it becomes rather thin. In wet rich conditions it grows thickly. Then there is *Eulaliopsis binata* (Retz.) C. E. Hubbard, the *Baib* or *Sabai* grass, which gives such an important revenue in Uttar Pradesh. The hairy base of the plant and its golden racemes are very distinctive.

It is, however, the bamboos which are of such immense importance to the forest officer and, while it is not possible to give a key to the species, some account of these interesting plants must be given.

¹ Imperial Agricultural Bureaux, Joint Publication, No. 7, 1944.

The underground system of a bamboo is a rhizome branched in a most complicated manner. Segments or sections of the rhizome plexus are sometimes, but not always, pear-shaped with the narrow end issuing from the parent segment. Assimilating roots are developed from the distal ends of the rhizome-segments, and culms or stems from the upper surface at the distal end. In some species the rhizome-segments give off numerous vertical culms so that a clump is formed and consequently the rhizome-segments become crowded below ground to an extraordinary degree so that succeeding rhizome-segments are produced above ground and the whole plexus becomes twisted and interlaced into an inextricable mass. The clumps of *Dendrocalamus strictus* at the Forest Research Institute are an excellent example of the extreme complexity of the rhizome of bamboos. In other species, such as *Melocanna bambusoides*, the rhizome spreads widely in all directions so that instead of a clump of bamboos the culms are spaced. This character is a most important factor in determining what vegetation will succeed after primeval forest has been felled for hill-cultivation. The bamboo-seedling in general finds great difficulty in competing with other grasses and vegetation and really does not become established until the rhizome-system is well developed. Forest with an undergrowth of tufted bamboos will return to forest if it has been felled, because the tree-seedlings have room to grow unmolested by bamboo-shoots.

Imagine now a forest in which the undergrowth is one of the bamboos with a widely spreading rhizome, i.e. with spaced culms. Should the forest, including the aerial parts of the bamboos, be felled and a crop or two taken off the soil, there is little hope of a normal succession. The reason for this is that the rhizome of the bamboo is not damaged and, when the field is abandoned, immediately sends up culms which have no competition and take complete possession of the soil.

In parts of the Naga Hills and on the hills of Sylhet and in Burma the forests of *Arundinaria griffithiana* and *Melocanna bambusoides*, which cover enormous areas, have arisen in this fashion. These bamboo forests are extraordinarily pure and regeneration of tree species is effectively prevented by the bamboo.

Incidentally one use, a nefarious one, has been found for the rhizome of bamboo. It was discovered that a model of a rhino horn, indistinguishable by ordinary means from the real article, could be cut from a rhizome of *Dendrocalamus hamiltonii*. Some of the smugglers of this aphrodisiac were badly stung by 'innocent' Assamese villagers and this uncertainty in their business eventually led to the collapse of the trade.

For vegetative propagation a rhizome-segment carrying a

culm-bud is taken and planted. A complete plant will grow from such a portion of the parent. Small culms and branches, cut and stuck in the soil, occasionally produce new individuals. It is advisable, however, when propagating in this way, to select a time when the bamboo shoot is packed with starch. Similarly, if whole culms are cut from the clump and laid upon the ground, just after the break of the rains, the lower nodes send out roots which eventually grow into individual plants.

The mature culms of bamboo usually consist, as everyone knows, of hollow internodes separated by transverse dissepiments, the nodes. As a single culm can complete its growth in a single growing season it will be surmised that the growth in height is rapid. Three feet in one day has been recorded, but most bamboos cannot show such impressive figures as this. Still one to two feet in a single day is not uncommon. Growth is often resumed the following year but it is rare for a culm to grow to any extent in length. The enormous buds as they break through the soil at the onset of the monsoon are remarkable. They are solid, and incidentally remarkably good eating. They consist very largely of the culm-sheaths, of which every node is provided with one. As the culm grows in length the culm-sheaths also grow and sheathe the culm all along. The culms, at first soft, soon become hard by reason of a deposit of silica in the walls and nodes. In the axil of each stem-sheath is a bud which may grow out into a branch. The culm-sheaths are distinctive for each species of bamboo. They are smooth and glabrous or may be covered with a thick or thin tomentum of various colours. At the top the sheath is auricled, provided with a ligule and with a short or long blade, erect or reflexed. The walls and nodes of the culm contain starch but the amount of the starch varies with the season of the year. Culms about to flower are packed with starch, which is all used up in the production of flowers and seed. Since it is the starch in the culm which attracts the borers, bamboos should be harvested when the starch is at its minimum.

In the hollow internodes a little liquid is not infrequently found which apparently is an exudation of sap. Comparatively rarely a crystalline substance known as *Tabashir* is found in the internodes, which possibly represents the solids left behind after a considerable quantity of sap has evaporated. This substance is almost all silica, but despite this has acquired a most enviable reputation as a drug in eastern countries. The list of diseases which are supposed to be cured by it is quite impressive, but apparently modern medicine has been unable to find out to what these magical powers are due.

There is great variation in the length of culm. Some of the high-altitude *Arundinarias* are at most a foot or so high while at

the other end of the scale comes *Dendrocalamus giganteus* with stems up to 120 ft. high and 9 in. thick. Some bamboos have very thin walls while in others the lumen of the internode is very reduced and the walls are strong and thick. Some of the culms of *Dendrocalamus strictus* are actually solid and are greatly valued for lance-shafts. Not all bamboos are erect and quite a number exist which are scramblers and even climbers.

Many people think of the culm of a bamboo as a shining glossy smooth surface. Even to this picture there are exceptions. The culms of *D. hamiltonii* are rough to the touch and dull. The nodes of *Bambusa arundinacea* and that of several species of *Arundinaria* are spiny.

The leaves of the bamboos are alternate and distichous, often petioled and attached to a rather coriaceous sheath. The leaves are usually oblong-lanceolate in shape but there are wide variations from the mean. The margins are smooth or scabrid. The nervation of the leaf-blade is longitudinal or tessellate.

The inflorescence of bamboos shows a very wide range of variation. In the case of those bamboos which are monocarpic, i.e. which only flower once in a lifetime, the whole plant, culm, branches and even the roots and rhizome, are transformed into a gigantic inflorescence. The axillary buds which are normally dormant send forth slender branches which bear flowers. Suckers are sent up from below ground and these too bear flowers. Every leaf-sheath harbours a raceme or a panicle. It is as if, before its death, the bamboo sacrifices everything to the production of flowers and fruits; and these it produces in abundance.

This periodical flowering of the bamboos is a most remarkable performance. It is as if every seed were provided in its germ-plasm with an alarm-clock set to go off at a certain time, 40, 60 or 100 years, or more, in the future. No matter where these seeds have gone to, when the alarm-clock goes off, the mature stems to which they gave rise begin to produce flowers. The habitat does appear to have some influence upon the timing but, roughly speaking, flowering takes place at the same time. Very often it takes place exactly at the same time. *Thyrsostachys oliveri* flowered in Burma in 1891. Seed was sent to Calcutta and Dehra Dun and clumps were raised at both places. In 1940 this species of bamboo began to flower in both these localities.

Gregarious flowering over wide areas, where a single species is gregarious, is a very common phenomenon, especially in Burma which can be considered the home of the bamboos. After this gregarious flowering the bamboo clumps die and are

replaced by the millions of seedlings which cover the soil, only a fraction of which come to maturity. That the locality has some effect upon time of flowering is proved by the fact that one single species does not flower in all climates at the same time though all the members of that species in a definite circumscribed climate do flower simultaneously.

Some species, in addition to a periodical flowering, flower to some extent every year. *Dendrocalamus strictus* and *D. hamiltonii* belong to this category and flowering shoots of both may be obtained nearly every monsoon. The particular culm which has produced the flowers will die but not the whole clump. These two species flower gregariously on a cycle of about thirty years. One strange thing about this gregarious flowering is that all seedlings, offsets and single stems that are being vegetatively propagated, even stems which have recently been made into fences, all flower at the same time. If pollen is required, say for genetical purposes, the period of flowering of one of these bamboos can be prolonged by periodically potting parts of the rhizome. Such pieces will, two or three months after being put in a pot and watered, give fertile pollen and will continue to flower long after the parent clump has died. No entirely satisfactory explanation is available of this periodical flowering in bamboos. Some writers have put it down to extremes of climate, some to ill-treatment, and one has endeavoured to correlate it with the appearance of sun-spots. Actually a number of isolated cases of irregular flowering were observed in Assam in 1942-5 where literally millions of bamboos were cut by the army, so that ill-treatment may hasten what appears to be a natural phenomenon.

There are two types of fruit produced by the bamboos. One is the caryopsis which consists for the most part of endosperm and contains a small embryo which is situated at the base on the outside. The embryo is connected to the endosperm by the scutellum which actually is the cotyledonary body. The other is a large fleshy fruit which differs widely in structure from the ordinary fruit of grasses. In this type of fruit, which is found in the genera *Melocanna*, *Ochlandra*, *Dinochloa* and *Melocalamus*, there is no endosperm, or very little, in the true seed. On the other hand the cells of the pericarp have enlarged and multiplied to a very great extent and these cells are packed with starch grains. In this fruit the embryo develops a very large scutellum, which eventually fills up this cavity of the pericarp. The fruit of *Melocanna bambusoides* may be 5 in. long by 3 in. wide, and, as it is edible, is a very important additional source of food when this bamboo flowers. Actually all bamboo seed is collected and eaten. There is a connexion between the gregarious flowering of bamboo and plagues of rats, a pheno-

menon which is well known in eastern countries. The increased food supply provided by the enormous quantities of seed produced leads to an equally large increase in the number of rats. The following year, when there is no bamboo seed for the rats to feed upon, they attack the crops and play havoc in the fields and even in the villages.

Much remains to be learned about the bamboos; even about their taxonomy. For this reason forest officers should make it a rule never to pass a bamboo clump in flower without taking a specimen of the flowers, the leaves and the culm-sheath and sending them to the Forest Research Institute.

GETTING TO KNOW THE TREES

STUDENTS often ask the question: What is the use of learning the names of all the trees and shrubs when only a few are of commercial value? There was a time when a knowledge of the timber-trees in his forests was all that was required of a forest officer, but that time is long since past. We now know, from a study of ecology, that so far from being the worthless objects the forest officer thinks, the subsidiary species are at least equal in importance to the most valuable trees when the well-being of the forest is considered.

A forest, no matter what its status may be, reacts to the impact of Man in different ways. If it be a climax unit the activities of Man may upset the harmony which exists between the vegetation, soil and climate. If it be a seral unit the interference may speed the progression or retard it. In either case the subsidiary species are affected just as the valuable species are affected.

Perhaps the most striking example of the need for knowing the subsidiary species is the lesson that can be learned from the results of the study carried out at the Forest Research Institute¹ on the biological control of the teak defoliators *Hyblaea puera* and *Hapalia machaeris*. These two defoliators probably exist in all forests and plantations of teak but are controlled by their natural parasites, predators and diseases. Now, the natural control is the result of the fact that the whole entity is a living unit, in harmony with its individual members and with the environment. Fluctuations in the insect population do occur but any increase in numbers leads to an increase in the number of predators and parasites present and the surplus is soon reduced to normal proportions. A careful biological study of the whole problem revealed that there is a reserve population of parasites and predators in the forest or plantation. The parasites and predators maintain themselves upon the bodies of certain insects which feed upon the leaves of certain herbaceous shrubby or small tree species (about 47 all told) which are normally present in the forest. Therefore, as long as these 'worthless' species are maintained there will always be a considerable number of parasites and predators of the teak defoliators in the forest or plantation, which will be ready to deal with any marked increase of defoliators.

¹ See *Ind. For.*, 60 (1934), p. 672 and 64 (1938), p. 485.

On the other hand there are about eight species of trees which are undesirable in a teak forest because they are alternative food-plants for the two pests of the teak tree.

The point therefore is this: the forest or plantation must contain as undergrowth and underwood certain species which to the ordinary forest officer are completely worthless, but vital to the well-being of the teak. The logical conclusion, therefore, is that the forest officer must learn, distasteful though the process may be, to recognize the subsidiary species whose presence is so beneficial to the forest as a whole.

There is little doubt that ecology is now recognized as forestry's fundamental science. This being so it is quite certain that forest officers will be expected in the future to know a great deal more about the small trees and shrubs, as well as herbs, which are such an important part of the biome, than they have done in the past.

Gone are the days when a forest officer's interest was bounded by the names of a few timber-trees and all other trees were relegated to *kokat*, while shrubs and herbs were merely so much undergrowth which rendered natural regeneration more difficult. He must get to know which trees and shrubs are beneficial to the main crop and which are harmful. He must know the plants which indicate edaphic differences, since these are very important to a planned forestry.

Now, all of this knowledge cannot be imparted to a student at the Forest Colleges; it is knowledge which must be learned in the forest. The pity of it is that, until a race of forest officers grows up which is conversant with the trees and shrubs, most young officers of this generation will have to find out for themselves and get to know these small trees and shrubs as best they may.

A great deal can be learned from the indigenous people, who have their own methods of identifying trees and who, the learner will observe, rely upon bark, slash, leaf, smell and other characters. Too much reliance should not be placed on local names, for these names very often only have a generic significance and even may cover trees which are not even congeners.

Until the scientific name of a plant can be found it is much the best plan to adopt a local name and list the characters by which the tree bearing the name may be known. If there is no local name, make up one, again for a tree with very definite characters. The writer has found that such a name, if plain and understood, will be adopted by mazdoors and will be applied unfailingly to the tree to which it refers. Jungle folk are very quick to notice differences and the reason for there not being a name for each tree and shrub is the fact that it is not

necessary for their purposes. For each plant for which they have a use they have a name.

The purpose of this chapter is to help young officers so placed and to give them an idea of what to look for. If the officer is lucky enough to be stationed in Bengal, Bombay or Madras States where permanent botanical gardens (enumeration lines) inside the climax forest are maintained, he will get to know his trees with the minimum of trouble. He gets to know the subsidiary species, as he recognizes his timber-trees by its look, the colour of its bark, the nature of the blaze or slash, shape of the leaves and so on.

The shapes of trees outside the forest are often distinctive. Flat topped trees include *Enterolobium saman* and *E. timbouva*, *Delonix regia*, *Albizia* spp., *Acacia* spp. and so on. Conical shaped trees include *Cryptomeria*, *Thuya*, many other *Coniferae*, *Mesua ferrea*, *Polyalthia longifolia*, *Millingtonia hortensis*. Round and bushy trees include *Mangifera indica*, *Tamarindus indica*, *Nephelium* spp., *Pterygota alata* etc. Trees with weeping branches may be species of *Salix*, *Zizyphus jujuba* etc.

As, however, growth within the forest means that each tree is subject to the effect of its neighbours, so the individual characteristic shape of a tree is often masked. Actually the type of branching, sympodial or monopodial, determines the final shape of a tree. Most bushy trees are sympodial, conical trees monopodial in their mode of branching.

BRANCHES

The whorled branching of *Garcinia*, *Salmalia malabarica*, *Chorisia speciosa* and *Anthocephalus indica*, enables these trees to be recognized at a glance. The long straight branches, drooping at the tips, of *Duabanga grandiflora*, *Myristica* spp., *Polyalthia* spp. and other species of the *Annonaceae* single out this type of tree from all others. The dichotomous branching of the stems of *Hyphaene* and *Pandanus* spp. is very striking.

STEMS

Very often the shape of the bole of a tree is of material assistance. Anyone with an eye for symmetry will remember the cylindrical stems of *Dipterocarpus*, *Elaeodendron*, *Calophyllum*, *Poeciloneuron*, not to mention the coniferous trees. The irregular boles of *Dillenia*, *Lagerstroemia*, *Stereospermum*, *Mesua ferrea* and many others are equally distinctive. *Adansonia digitata* has the lower parts of the stem swollen in a grossly obese fashion. The stem of *Chorisia speciosa* is bottle-shaped. The stem of the palm *Roystonea regia* (*Oreodoxa regia*) is wide just at the base, then contracts and finally expands from the middle upwards. The stems of the epiphyte

Hydnophytum formicarium are swollen and inhabited by ants. The stems of the shrub *Clerodendrum indicum* are also occupied by ants.

Passing from stems to roots, we know of many species which have surface roots snaking over the soil and among these the *Terminalias* occupy a prominent place. Many of this type of trees develop plank buttresses, but it is well to remember that these plank buttresses, so conspicuous on old trees, are often only developed in middle life.

BUTTRESSES

The following families and genera develop conspicuous buttresses.

<i>Anacardiaceae</i> :	<i>Melanorrhoea</i> , <i>Dracontomelum</i>
<i>Bombacaceae</i> :	<i>Salmalia</i> , <i>Ceiba</i>
<i>Burseraceae</i> :	<i>Canarium</i>
<i>Caesalpiniaceae</i> :	<i>Delonix</i> , <i>Acrocarpus</i> , <i>Intsia bakeri</i> , <i>Dialium</i>
<i>Combretaceae</i> :	<i>Terminalia</i> spp.
<i>Datiscaceae</i> :	<i>Tetrameles nudiflora</i>
<i>Guttiferae</i> :	<i>Mesua ferrea</i> (old trees)
<i>Juglandaceae</i> :	<i>Engelhardtia</i> spp.
<i>Malvaceae</i> :	<i>Durio zibethina</i>
<i>Mimoseae</i> :	<i>Parkia</i> spp.
<i>Rhizophoraceae</i> :	<i>Bruguiera</i> , <i>Ceriops</i>
<i>Sapotaceae</i> :	<i>Palaquium</i>
<i>Sterculiaceae</i> :	<i>Pterospermum</i> , <i>Sterculia</i> , <i>Firmiana</i>
<i>Urticaceae</i> :	<i>Gironniera</i> , <i>Ficus</i>

ROOTS

Stilt roots, when present, are structures which cannot be overlooked and are diagnostic. Such trees are *Pandanus* spp., *Rhizophora* spp., *Bruguiera sexangula* (the only species of *Bruguiera*), *Elaeocarpus* spp., occasionally *Dillenia indica* and *Poeciloneuron indicum*. In the latter the roots become more arched and flattened with age.

Pneumatophores are very common among the various species of the mangrove genera *Carapa* (*Meliaceae*), *Avicennia* (*Verbenaceae*), *Sonneratia* (*Sonneratiaceae*).

The aerial roots sent down from the branches by certain species of *Ficus* (notably the Banyan) will be known to everybody. *Carallia* (*Rhizophoraceae*) also possesses bunches of aerial rootlets on stem and branches, which never seem to come to anything.

CAULIFLORY

Flowers and fruits are sometimes borne on the stems of trees. Examples of such trees are *Gynocardia odorata*, some *Annona*-

ceae, *Baccaurea sapida*, *Couroupita guianensis*, *Saraca indica*, *Calliandra* spp., and many species of *Ficus*.

SPINES ON STEMS

On the stems of certain trees are sometimes found outgrowths, which take the form of spines, either branched or simple. The branched spines of *Gleditsia* and *Flacourtia* are well known. The stems of *Salmalia*, *Chorisia*, *Ceiba*, *Scleropyrum*, *Zizyphus incurva*, *Erythrina* and *Zanthoxylum* spp., are covered with thick-based squat spines, which eventually become corky-based and can be struck off with a smart blow. In certain palms branched spines, as sharp as needles, are developed between the petiole of the leaf and the stem, and only become prominent after the fall of the leaf. The sheaths of the leaves of the climbing species of *Calamus* develop needle-like spines.

THE BARK

The bark of a young tree is often smooth and of a different colour from that of the old tree. For example the bark of a young pole of *Bucklandia populnea* is black, that of older trees is brown and deeply fissured. Actually the colour of the bark is not much help since it is often obscured by a growth of lichens, especially on the smooth-barked trees. Trees with papery or flaking bark are not troubled with lichens, nor epiphytes such as orchids, for that matter. The bark of some species is so hard and resonant that if struck by a smart blow with the back of a dao it gives out a clear ringing sound. Such a tree is *Canarium resiniferum*.

Trees with a smooth bark are many species of *Ficus*, *Lauraceae*, *Myristicaceae*, *Tetrameles nudiflora*, *Garcinia* spp., *Hevea*, *Morus* and many *Leguminosae*.

Examples of trees with fissured bark are *Shorea*, *Pinus*, *Calophyllum*, *Erythrina*, *Moringa* etc.

Powdery bark is characteristic of *Aporosa* spp. and *Bischofia javanica*.

Crustaceous bark is possessed by many species of *Diospyros*. The bark is black outside, hard and gritty.

Papery bark; *Dillenia indica*, *Betula* spp., *Prunus cerasoides*, *Carapa* sp., *Commiphora caudata*.

Bark exfoliating in patches or strips is exhibited by *Lagerstroemia parviflora*, *Gmelina arborea*, *Albizia stipulata*, *Platanus orientalis* and many others.

Crocodile-skin bark, i.e. fissured horizontally and vertically, forming rectangular plates: *Buchanania lanzan*, *Ougeinia dalbergioides*, *Elaeodendron* spp.

The bark of certain species always seems to be attacked by a borer, and a slanting cut shows the black burrows of the insect. Such a tree is *Derris robusta*.

THE SLASH, BLAZE OR CUT

Much can be learned of the identity or relationships of a tree from the nature of the blaze. The bark of every species is different and varies in the most diverse ways: it may be thick or thin, hard or soft, of a uniform colour or parti-coloured, with lighter bands or darker specks or laminated, or the colour may change on exposure to the air; the texture may be smooth or rough, greasy or dry. One of the most characteristic things about the blaze is the juice, when present, which pours from it or becomes visible as drops of liquid. The trees below are classified according as the sap or latex is colourless, white, yellow or red.

COLOURLESS SAP

Many species of *Ficus*
Tetrameles nudiflora

WHITE LATEX

Anacardiaceae: *Parishia insignis*, *Rhus* spp.
Apocynaceae: All species
Asclepiadaceae: " "
Caricaceae: *Carica papaya*
Compositae: *Notonia* spp.
Euphorbiaceae: *Euphorbia*, *Manihot*
Guttiferae: *Mesua ferrea*
Meliaceae: *Amoora* spp. *Lansium* spp.
Moraceae: *Morus*, *Castilla*, *Artocarpus*, *Streblus*,
 etc.
Sapotaceae: All species except *Monothecca*

WHITE TURNING MUDDY BROWN

Antiaris toxicaria

YELLOW LATEX

Guttiferae: Most species of *Garcinia*, *Ochrocarpus*
Bixaceae: *Bixa orellana*
Malvaceae: *Thespesia* spp.
Papaveraceae: *Argemone mexicana*

RED JUICE

Bixaceae: *Bixa orellana*
Euphorbiaceae: *Bischofia javanica*
Myristicaceae: All species
Papilionaceae: *Butea monosperma*

RED GUM

Euphorbiaceae: *Macaranga* spp.
Papilionaceae: *Ougeinia dalbergioides*, *Pterocarpus*
dalbergioides, *Butea* (*Spathololus*)

RESINOUS

Canarium spp.

COLOURLESS GUM

Anacardiaceae: *Spondias*, *Lannea**Burseraceae*: *Bursera**Dilleniaceae*: *Dillenia*

WHITE OR GREY JUICE TURNING BLACK

Anacardiaceae: Spp. of *Holigarna*, *Melanorrhoea*, *Swin-tonia*, *Nothopegia*, *Semecarpus* etc.

The actual colour and texture of the slash or blaze is often helpful but since each one is different it is a question of getting to know the individual trees by their blazes. A few examples are given here to indicate the diversity of this character.

<i>Lannea grandis</i> :	Crimson, marked with pink and white
<i>Schima wallichii</i> :	Red, spongy, with numerous crystals of oxalate
<i>Ilex godajam</i> :	Bark horizontally wrinkled; blaze white with a red or purple ring next the bast
<i>Diospyros montana</i> :	Cream turning green
<i>Cordia dichotoma</i> :	White turning dirty-green
<i>Lophopetalum wightianum</i> :	Flesh-coloured with a bright-yellow layer under the cuticle
<i>Premna</i> spp.:	White, brittle, sweet, with a thin chlorophyll layer under the cuticle
<i>Zanthoxylum rhetsa</i> :	Yellow, fibrous, soft
<i>Buchanania lanzan</i> :	Red
<i>Ougeinia dalbergioides</i> :	Blood-red streaks on a white ground
<i>Strombosia ceylanica</i> :	Laminated pink and white
<i>Albizzia leucophloea</i> :	Light-red
<i>Celtis australis</i> :	Chocolate with lighter specks
<i>Alseodaphne owdenii</i> :	Dun-brown, mottled, turning reddish-brown
<i>Machilus macrantha</i> :	Pink, greasy
Aromatic blaze:	<i>Lauraceae</i> especially spp. of <i>Cinnamomum</i>
Blaze with an unpleasant odour:	<i>Celtis</i> spp.
Blaze smelling of crushed almonds:	<i>Pygeum</i> spp.

Blaze sweet-smelling: *Cedrela* spp.
 Blaze white with darker
 specks, soft, mucilaginous: Spp. of *Machilus*

LEAVES

Leaves develop from buds and the buds are protected in various ways. This duty is often undertaken by the stipules, and the stipule, if present, can often give much information. They vary tremendously in size and those of species of *Dipterocarpus* are so large that they are conspicuous on the forest floor at certain times of the year. The stipules of the *Dipterocarpaceae* and *Magnoliaceae* leave a circular scar on the twig after they fall. At the other end of the scale are those species with very minute stipules or none at all. In two families with opposite leaves, *Rubiaceae* and *Rhizophoraceae*, the two adjacent stipules grow together and are called interpetiolar stipules. Stipules take the form of thorns in the genus *Zizyphus* with the peculiarity that one of a pair is straight, the other curved. Hutchinson¹ gives lists of families which constantly have stipules, others without stipules and so on. The stipules may be caducous; if so, they leave behind a small scar.

From the buds come the leaves and twigs. The leaves consist of petiole and blade.

The petiole may be very short or quite long and may be glabrous, hairy or covered with scales. Sometimes a number of sessile or stalked glands may be present. The petiole is usually straight but may be curved at the end so that the blade is set at an angle and gives the tree a characteristic appearance. Such a species is *Mallotus philippensis*. In a number of species the petiole is peltately attached to the blade, e.g. *Macaranga* and *Mallotus*. In certain species of *Citrus* and in *Vitex peduncularis* the petiole is winged. The leaf-blade may be absent altogether or reduced to scales, the actual business of photosynthesis being taken over by the stem or flattened petioles. Plants of this kind are to be found in the *Mimoseae*, *Asclepiadaceae*, *Euphorbiaceae* and *Liliaceae*. Parasites or hemiparasites like *Cuscuta*, *Arceuthobium*, *Cassytha* and *Viscum* have very small leaves or none at all. The leaves of species of *Casuarinaceae* and *Tamaricaceae* are needle- or scale-like.

According as leaves are simple or compound, the first great division in drawing up a key according to leaf-characters can be made. Compound leaves may be digitate (*Ceiba*, *Salmalia*), pinnate (*Meliaceae*), bipinnate (*Albizia*), tripinnate (*Moringa*) or quadripinnate (*Oroxylum indicum*). The shape of leaves is helpful but this character has its limitations. One thing to remember is that the leaves of some species, when young, have

¹ *Families of Flowering Plants*, vol. I, p. 80.

a different shape from that of the older leaves. The young leaves of species of *Artocarpus*, *Broussonetia*, *Eucalyptus* and *Populus* are quite different from the older leaves, and not only the leaves of seedlings but also those on coppice-shoots and root-suckers.

The leaf of *Bauhinia* is quite unmistakable as it seems to consist of two leaves joined below and seated on a common petiole. The leaves of *Bauhinia malabarica* are sour or acid to the taste.

The texture and venation of leaves are often of great help. A leathery glabrous lamina with very many parallel nerves can often be placed at once in *Guttiferae* (*Calophyllum*, *Mesua*, *Poeciloneuron*) or, if it is covered with rusty scales, it is almost certain to be *Cullenia excelsa*.

Leaves with a conspicuous intramarginal vein may belong to *Myrtaceae* (*Eugenia*, *Eucalyptus*) *Rhizophoraceae*, some *Anacardiaceae* (*Drimycarpus*). One of the best features of diagnostic value is the presence of pellucid cells in the leaves of certain genera and families, which manifest themselves as translucent dots when a leaf is held up to the light. Hutchinson gives lists of such families.¹ These glandular dots are very common in *Rutaceae*, *Myrtaceae*, *Hypericaceae*, *Samydaceae* (streaks and dots), *Chloroxylon* (*Meliaceae*). In *Acanthaceae* a somewhat similar phenomenon is visible, but here the translucency is due to linear cystoliths, which are often very conspicuous as raised lines on the surface of the dried leaf.

Leaves with 3-5 basal nerves are often characteristic of some genera: *Zizyphus* (*Rhamnaceae*), *Lindera*, *Neolitsaea*, *Cinnamomum* (*Lauraceae*), *Grewia* (*Tiliaceae*), *Myxopyrum* (*Oleaceae*), *Smilax* (*Liliaceae*), *Rhodomyrtus* (*Myrtaceae*), *Trema* (*Ulmaceae*), *Melastoma*, *Memecylon*, *Osbeckia* (*Melastomataceae*), *Strychnos* (*Loganiaceae*).

The difference in colour between the different shades of green in forest trees may be very difficult to express in words but is often quite definite to the eye and can be made use of in spotting trees. The *Lauraceae* often have a glaucous bloom on the under-surface of the leaf. The oak *Quercus lamellosa* can be distinguished at a distance by the white under-surface of the leaf; and so it is with many others.

The young leaf is often of a very different colour from the green of the mature leaf. Some leaves start their existence with a pale chlorotic-green colour, or deep-red, or various shades of red or green. *Mesua ferrea* can be very beautiful in spring with its pale-green or almost white young leaves passing through pink and red shades to the glossy deep-green of the mature leaf. Some leaves are even bright-blue in colour when young; such are those of *Crypteronia* and *Memecylon*.

¹ *ibid.*, vol. I, pp. 79-80.

Many of the trees in the hill-districts, where a very cold winter is experienced, show pretty autumn shades at the end of the rains. Some of the trees common to the plains, however, have constantly a few bright-red or orange leaves in the crown. Such are the genera *Cinnamomum*, *Planchonia*, *Rhus*, *Sapium* and *Elaeocarpus*. *Terminalia catappa* is another tree whose leaves turn bright-red before falling. The leaves of *Strombosia* turn greyish-blue as they fade and dry.

The leaves of some species contain numerous conspicuous, coloured glands. The leaves of teak, for instance, when rubbed between the hands colour them red. The leaves of several species of *Croton* are covered on the lower surface with yellow glands. The under-surface of the leaves of *Mallotus philippinensis* are crowded with crimson glands, which can be made out with the naked eye.

Then, again, the leaf-surface may be covered with various types of hair or lepidote. Stellate hairs are common in *Malvaceae*, *Tiliaceae* and *Sterculiaceae*. Lepidote scales are found in *Eleagnaceae*, some *Sterculiaceae* and *Cullenia* of the *Malvaceae*. The branched hairs of *Malpighiaceae* are 1-locular.

FRUITS

The fruits of many kinds of trees and shrubs are quite distinctive and may indicate family, genera or species. The fruits of coniferous trees are well known while the pods of the leguminous species and figs are unmistakable. Fruits can be classified in various ways and this is a great help in diagnosis.

PODS

Most people would be willing to wager that they would always recognize the pod of the *Leguminosae* (*sensu lato*) but some other families and species actually develop fruits which are indistinguishable from pods. It is well to remember that the pods of the leguminous species are not always dehiscent, especially in those species in which only one ovule in the carpel develops into a seed, while the rest of the carpel turns into a wing. Such fruits are indistinguishable from the flat 1-seeded indehiscent fruits of *Ailanthus* (*Simarubaceae*). In this family the ovary consists occasionally of separate carpels and the fruit of *Ailanthus* is what a single carpel develops into. Examples of fruits which are samaroid 1-seeded pods are the genera *Pterocarpus*, *Derris*, *Pterolobium*, *Butea*, *Dalbergia* and *Hardwickia*. The genus *Parkia* is very striking when in fruit. The bunch of long, lax, oblong pods limply pendulous from the end of the drooping peduncle is very characteristic and, once seen, is not likely to be forgotten. Many species of *Leguminosae* develop flat pods (*Albizzia*, *Mezenerium*) which look as if they were some adaptation for wind-dispersal, but as many of these pods dehisce and

fing out the seed, it is difficult to see any reason for their shape.

The opposite extreme, the inflated pod, is well seen in *Crotalaria* and in the cylindrical pods of the genus *Cassia*. The pods of *Desmodium* are characteristic of the genus in that the pod breaks up into quadrangular pieces, each of which contains one seed. Some of the species develop hooked spines on the surface of the sections which adhere to the hair and fur of animals, and assist in dispersal in this way.

The genus *Sophora* develops characteristic pods which are termed moniliform, i.e. they are constricted between the seeds so as to give the impression of a necklace. The pods of *Enterolobium timbouva* are horseshoe-shaped. Those of *Pithecellobium* are curved and spirally twisted. The falcate pods of *Delonix* and *Bauhinia* are well known.

ROUND FRUITS

The fruits of *Dillenia indica* (Dilleniaceae), *Hydnocarpus*, *Gynocardia* (Flacourtiaceae), *Pterygota alata* (Sterculiaceae) and *Crataeva roxburghii* (Capparidaceae) are more or less spherical and large. The spherical fruits of *Annona* (*A. squamosa* and *A. reticulata*) will be known to all.

CAPSULES

Capsules containing seeds enveloped in floss are found in the *Malvaceae* and *Bombacaceae*. Genera which possess such fruits are *Salmalia*, *Ceiba*, *Cochlospermum* and *Gossypium*. Capsules containing winged seeds are found in *Lophopetalum*. Capsules like little woody figs are the fruits of *Lagerstroemia* (Lythraceae), and *Schima wallichii* (Theaceae) develops very similar fruits. In *Schrebera* (Oleaceae) the 2-valved capsule is 2-3 in. long, pear-shaped, woody. *Harpullia cupanioides* (Sapindaceae) develops a characteristic and striking 2-valved capsule, which is a brilliant orange-red in colour.

DRUPES

A great many families, among them *Lauraceae*, *Rosaceae*, *Elaeocarpaceae*, have fruits which are very often, but by no means always, drupaceous. A few distinguishing characters are the following. The drupe of *Lauraceae* is often seated in a little cup. In one genus of the same family, *Cryptocarya*, the perianth is accrescent and covers the fruit, and the tip is visible as a small knot at the apex of the fruit. In the genus *Machilus*, again of the same family, the spherical drupaceous fruits are supported below by the reflexed lobes of the perianth.

FOLLICLES

In the following families a follicle is the common form of fruit, especially in the first four families: *Apocynaceae*,

Asclepiadaceae, *Bignoniaceae*, *Moringaceae* and *Sterculiaceae*. The bunch of red boat-shaped follicles of many of the *Sterculiaceae* is diagnostic. The follicles of *Asclepiadaceae* often contain seeds with a tuft of hair at one end. The seeds contained inside some follicles of *Bignoniaceae* are winged, i.e. *Millingtonia*, *Oroxylum*, *Pajanelia* and *Mayodendron*. The follicles of *Ervatamia* (*Apocynaceae*) are scarlet inside.

WINGED FRUITS

Calyx developed as a wing or wings:

Dipterocarpaceae: nearly all

Sapindaceae: *Zollingeria*

Follicle developed into a wing:

Sterculia colorata

Petals enlarged in fruit as wings:

Anacardiaceae: *Swintonia*, *Melanorrhoea*

Hernandiaceae: *Gyrocarpus*

Fruit 1-seeded, with 1 or more wings:

Anacardiaceae: *Dobinea*

Aceraceae: *Acer*

Ancistrocladaceae: *Ancistrocladus*

Combretaceae: *Terminalia*, *Combretum*, *Anogeissus*

Hernandiaceae: *Illigera*, *Gyrocarpus*

Malpighiaceae: *Hiptage*, *Aspidopterys*

Oleaceae: *Fraxinus*

Polygalaceae: *Securidaca*

Rhamnaceae: *Ventilago*, *Gouania*

Sapindaceae: *Dodonaea*

Simarubaceae: *Ailanthus*, *Samadera*

Tiliaceae: *Pentace*, *Colona*

Ulmaceae: *Ulmus*, *Holoptelea*

Fruit a capsule with one sepal foliaceous:

Rubiaceae: *Hymenodictyon excelsum*. The capsules remain long on the tree and the small dark foliaceous sepal is quite obvious.

Mussaenda spp. These are shrubs in which the foliaceous sepal is large, white, yellow or red, and is much more conspicuous than the yellow flower.

Hymenopogon parasiticus. This is a small epiphytic shrub of the hill-forests.

Fruits of families with apocarpous ovaries:

Ranunculaceae: A bunch of follicles

Annonaceae: A bunch of stalked ripe carpels

- Magnoliaceae*: Ripe carpels separated on an elongate torus or sometimes woody and coalescent; seeds with a red aril and suspended by the uncoiled vessels of the funicle
- Fruit an utricle:
Chenopodiaceae: *Salsola, Suaeda, Haloxylon*
Verbenaceae: *Tectona*
- Spiny fruits:
Fagaceae: *Castanopsis, Castanea*
Elaeocarpaceae: *Sloanea*
Sapindaceae: *Aesculus* (English species only)
- Fruit with involucrate wing-like bracts:
Verbenaceae: *Congea, Sphenodesme, Petraea, Symphorema*

SEEDS

- Seeds winged:
Betulaceae: *Betula*
Bignoniaceae: *Dolichandrone, Stereospermum, Oroxylum* etc.
Celastraceae: *Hippocratea, Lophopetalum, Kokoona*
Coniferae: *Pinus, Cedrus, Abies, Picea, Cupressus*
Crypteroniaceae: *Crypteronia*
Hamamelidaceae: *Altingia*
Hypericaceae: *Cratoxylon*
Lythraceae: *Lagerstroemia* spp.
Meliaceae: *Soymida, Chukrasia, Cedrela, Chloroxylon*
Moringaceae: *Moringa*
Proteaceae: *Grevillea*
Rubiaceae: *Neonauclea*
Sterculiaceae: *Pterospermum*
Theaceae: *Schima, Gordonia*
Violaceae: *Viola*
- Nut with a 3-lobed wing:
Juglandaceae: *Engelhardtia*
- Seeds horseshoe-shaped:
Menispermaceae
Resedaceae
- Seeds with a circular embryo:
Amarantaceae
- Seeds arillate in the following families:
Annonaceae: some
Connaraceae
Dilleniaceae

Euphorbiaceae: *Baccaurea, Glochidion*

Guttiferae: some

Magnoliaceae

Myristicaceae

Polygalaceae

Sapindaceae

Samydaceae

Seeds comose:

Asclepiadaceae: most

Apocynaceae: some

Tamaricaceae: *Tamarix*

Achene pappose:

Compositae

FLOWERS

If flowers are present it is presumed that there will be no great difficulty in running down the specimen to the family by means of the key. But it is a great saving of time if the family can be spotted right away. This is, for a goodly number of families, no magical feat for, if the student knows what to look for, he can very often relegate a plant to its family on a few characters only. A list of families is given below in which the combination of a few easily observed characters is quite sufficient to place the plant in its appropriate family.

Amarantaceae

Flowers of 5 chaffy scales with the stamens opposite them; embryo annular

Anacardiaceae

Leaves very leathery, alternate; juice white, drying black, caustic; ovary 1-locular; stamens often double number of petals, 1 in *Mangifera*

Annonaceae

Flowers trimerous; parts valvate; stamens spirally arranged; connective produced and enlarged

Apocynaceae

Leaves opposite or whorled; milky juice; corolla hypocrateriform, 5-lobed; stamens 5

Araliaceae

Woody; flowers in an umbel; fruit a berry

Asclepiadaceae

Leaves opposite or absent; milky juice; flowers 5-merous with a more or less complex staminal corona; pollen agglutinated in masses

Bombacaceae

Trees; leaves digitate; stamens monadelphous; anthers 1-locular; seeds embedded in cottony hairs

Caesalpiniaceae

Leaves pinnate or bipinnate; petals 5, clawed, one somewhat unequal; sepals 5, orbicular, imbricate; fruit a pod

Caprifoliaceae

Leaves opposite, joined by an inter-petiolar line, exstipulate; flowers gamopetalous, 5-lobed; ovary inferior

Cochlospermaceae

Trees with large yellow flowers; anthers 2-locular, dehiscing by terminal pore-like slits; fruit a capsule; seeds covered with woolly hairs

Compositae

Inflorescence a capitulum supported by overlapping bracts; anthers syngenesious

Connaraceae

Climbing shrubs; leaves imparipinnate; petals and sepals 5; carpels 5, free; stamens 5-10; seed arillate

Convolvulaceae

Twining; leaves alternate; corolla gamopetalous, 5-lobed, funnel-shaped; juice milky

Cruciferae

Stamens tetradynamous; petals and sepals 4; fruit a silique

Datiscaceae

Tall tree; sepals, petals and stamens 4

Dilleniaceae

Calyx-lobes enlarging in the fruit and becoming fleshy; stamens many; anthers opening by apical pores or lengthwise

Elaeagnaceae

Leaves covered on the under-surface with a silvery lepidote indumentum; flowers 4-lobed, lepidote

Ericaceae

Shrubs or trees; leaves leathery, alternate; flowers regular, gamopetalous, 5-lobed; stamens double number of lobes; anthers opening by pores

Guttiferae

Trees with horizontal branches; leaves opposite, leathery, with fine parallel nerves; juice white or yellow; flowers regular, petals and sepals 2-6; stamens numerous

Hypericaceae

Stamens in bundles opposite petals; flowers yellow; leaves pellucid-punctate

Labiatae

Usually herbaceous, often aromatic; corolla gamopetalous, 5-lobed, often 2- or 1-lipped; ovary 4-lobed; style gynobasic

Lauraceae

Trees or shrubs with aromatic leaves; anthers dehiscing by 2 or 4 valves; ovary 1-locular

Magnoliaceae

Stipular scars all round the twig; leaves leathery, alternate; apocarpous ovaries spirally arranged; stamens with large anthers and produced connective; tepals numerous; seeds with a red arillus

Malpighiaceae

Leaves opposite; calyx with large glands outside; hairs medifixed

Malvaceae

Shrubs or herbs; stamens monadelphous; staminal tube divided at the apex and bearing 1-locular anthers

Meliaceae

Leaves pinnate; stamens monadelphous (except *Cedrela*); petals 8-10, valvate; fruit a capsule or baccate

Mimoseae

Flowers minute, almost regular, collected into heads; foliage feathery; fruit a pod

Myrsinaceae

Leaves alternate, punctate; flowers wax-like; sepals and petals often punctate, sometimes black-dotted

Myrtaceae

Leaves opposite, glandular-punctate; stamens numerous; ovary inferior

Oleaceae

Stamens 2; leaves opposite; corolla gamopetalous

Papilionaceae

Flowers sweet-pea-like; fruit a pod

Rhamnaceae

Trees or shrubs with alternate or opposite leaves; calyx 4-5-lobed; petals 4-5; stamens 4-5, embraced by the petals

Rubiaceae

Leaves opposite, with interpetiolar stipules; gamopetalous corolla with inferior ovary

Sterculiaceae

Stamens monadelphous, divided at apex into filaments and as many staminodes; anthers 2-locular

Umbelliferae

Herbs or shrubs; flowers umbellate; fruit of 2 mericarps, prominently ribbed; ribs with vittae; petals 5; stamens 5

KEY TO THE FAMILIES OF DICOTYLEDONS¹

HINTS FOR USING THE KEY TO THE BEST ADVANTAGE

1. Examine the plant thoroughly.
2. Find out whether the carpels are free or united.
3. If the carpels are united into an ovary, see whether the ovules are on the walls or on a central axis.
4. How many stamens are there? Are they opposite or alternate with the petals?
5. Are the leaves opposite or alternate?
6. Are the leaves stipulate? Don't forget that the stipules may be caducous. If so, you will be able to make out a minute scar.

¹ The key has been adapted, with the permission of the author and Macmillan & Co. Ltd, from *The Families of Flowering Plants* by Dr J. Hutchinson, F.R.S.

KEY TO THE ARTIFICIAL GROUPS

Gynaecium (pistil) composed of 2 or more *separate* or nearly quite separate carpels with *separate styles* and stigmas (rarely the free carpels immersed in the expanded torus (*Nymphaeaceae*))

APOCARPAE

Petals present, free from each other, sometimes considerably modified

Group 1 (p. 379)

Petals present, more or less united

Group 2 (p. 382)

Petals absent

Group 3 (p. 382)

Gynaecium (pistil) composed of 1 carpel or of 2 or more *united* carpels with free or united styles, or if carpels free below, then the styles or stigmas united

SYNCARPAE

Ovules attached to the wall or walls of the ovary

PARIETALES

Ovary superior:

Petals present, free from each other

Group 4 (p. 383)

Petals present, more or less united

Group 5 (p. 387)

Petals absent

Group 6 (p. 389)

Ovary inferior:

Petals present, free from each other

Group 7 (p. 390)

Petals present, more or less united

Group 8 (p. 390)

Petals absent

Group 9 (p. 391)

Ovules attached to the central axis or to the base or apex of the ovary

AXILES

Ovary superior:

Petals present, free from each other

Group 10 (p. 391)

Petals present, more or less united

Group 11 (p. 405)

Petals absent

Group 12 (p. 411)

Ovary inferior:

Petals present, free from each other

Group 13 (p. 417)

Petals present, more or less united

Group 14 (p. 420)

Petals absent

Group 15 (p. 421)

GROUP 1

Two or more free carpels ; petals present, free from each other

Leaves opposite or verticillate (never all radical) (to p. 380):

Stamens numerous (15 or more):

Stamens arranged all to one side of the flower ; seeds arillate ;
trailing or climbing shrubs *Dilleniaceae*

Stamens arranged symmetrically around the carpels:

Ranunculaceae

Stamens up to 15 in number:

Carpels 3-7 ; flowers large ; petals yellow, not clawed, inserted at the base of a fleshy torus ; stipules paired, axillary ; anthers opening by terminal pores *Ochnaceae*

380 KEY TO FAMILIES OF DICOTYLEDONS

Carpels 5-10 ; petals persistent and thickened after flowering ; shrubs with angular branchlets ; stipules absent ; flowers small, green ; anthers large *Coriariaceae*

Carpels 1-3 ; petals often clawed, thin, not thickened after flowering ; stipules mostly intrapetiolar, often connate at the base ; sepals often biglandular at the base *Malpighiaceae*

Leaves alternate or all radical:

Leaves stipulate, sometimes the stipules minute or adnate to the petiole, or enclosing the young buds:

Carpels numerous, spirally arranged on a somewhat elongated receptacle ; sepals often 3 or indistinguishable from the 6 or more petals ; flowers solitary, mostly large and conspicuous ; seeds with copious endosperm and minute embryo ; trees or shrubs *Magnoliaceae*

Carpels few or numerous on a globose small or hollow receptacle ; sepals or calyx-lobes often 5, quite distinct from the petals:

Stamens free from one another or nearly so or shortly united into separate bundles ; calyx imbricate or valvate:

Herbs, more or less scapigerous, with mostly radical leaves ; seeds not arillate ; endosperm usually copious ; sepals mostly imbricate *Saxifragaceae*

Habit various ; seeds not arillate ; fruits follicular or indehiscent, often achenes arranged on a large fleshy torus ; endosperm absent or very scanty ; sepals mostly imbricate

Trees, shrubs or climbers, rarely herbs, with often scabrid prominently pinnately nerved leaves ; stipules adnate to the petiole ; seeds arillate, aril often lacinate ; calyx imbricate, often hardened in fruit *Rosaceae*
Dilleniaceae

Trees with large leaves and with stellate hairs ; seeds not arillate ; endosperm copious ; calyx valvate *Tiliaceae*

Stamens more or less united into a column ; calyx valvate ; hairs on the leaves often stellate or lepidote *Sterculiaceae*

Leaves without stipules:

Stamens alternate with the petals or monadelphous or more numerous (rarely fewer) than the petals:

Stamens numerous, more than 12, or more than double the number of petals (to p. 381):

Sepals and petals in 3 distinct series (3 + 3 + 3), rarely in 2 series:

Anthers usually with a broad truncate connective ; flowers usually hermaphrodite ; seed with copious ruminate endosperm and minute embryo ; trees, shrubs, or woody climbers *Annonaceae*

Anthers with a narrow connective ; flowers dioecious ; climbers *Menispermaceae*

Sepals and petals in 2 series or rarely the sepals gradually passing into the petals, usually in 4's or 5's, or rarely the petals numerous ; endosperm not ruminate:

Herbs, sometimes rather woody at the base:

Carpels in a single whorl and elevated on a stipe-like torus ; petals 3 or more times divided *Resedaceae*

Carpels not elevated on the torus, usually spirally arranged ; petals entire, bifid, or tubular ; *Ranunculaceae*

KEY TO FAMILIES OF DICOTYLEDONS 381

- Trees, shrubs or woody climbers:
 - Petals and stamens hypogynous:
 - Flowers hermaphrodite or very rarely polygamous:
 - Calyx imbricate:
 - Leaves aromatic, pellucid-punctate ; sepals deciduous ; seeds not arillate ; petals numerous *Winteraceae*
 - Leaves not aromatic ; lateral nerves prominent and parallel ; sepals persistent and often accrescent ; seeds often arillate *Dilleniaceae*
 - Calyx valvate ; indumentum stellate or lepidote:
 - Connective of anthers not enlarged *Tiliaceae*
 - Connective of anthers enlarged, not petaloid *Annonaceae*
 - Flowers unisexual *Simarubaceae*
 - Petals and stamens perigynous *Rosaceae*
- Stamens 12 or fewer, or double the number of petals when more than 6:
 - Leaves gland-dotted:
 - Leaves simple ; carpels in a spiral, mostly numerous ; stamens more or less united in a mass ; fruiting carpellary axis elongated ; flowers solitary *Schizandraceae*
 - Leaves often compound ; carpels whorled ; the axis in fruit not elongated ; stamens more or less free from one another *Rutaceae*
 - Leaves not gland-dotted:
 - Leaves compound:
 - Herbs ; seeds with copious endosperm and small embryo *Ranunculaceae*
 - Herbs, shrubs or trees ; seeds without endosperm:
 - Wood with resin ducts ; seeds not arillate *Anacardiaceae*
 - Wood without resin ducts ; seeds often arillate *Connaraceae*
 - Wood without resin ducts ; seeds not arillate *Rosaceae*
 - Leaves simple (sometimes the submerged ones of aquatics dissected):
 - Stamens free or slightly united at the base:
 - Flowers hermaphrodite:
 - Shrubs or trees ; seeds usually arillate:
 - Leaves reduced to scales ; aril lacinate *Dilleniaceae*
 - Leaves not reduced to scales ; seeds not arillate ; leaves pinnatisect ; carpels 5-10, with 2 ovules in the middle ; stamens 5 or 10 *Ranunculaceae*
 - Leaves not reduced to scales ; aril entire, more or less cupular ; carpels with 2 basal collateral ovules *Connaraceae*
 - Leaves not reduced, not pinnatisect ; no aril *Anacardiaceae*
 - Herbs ; seeds not arillate:
 - Carpels at the top of a gynophore *Resedaceae*

382 KEY TO FAMILIES OF DICOTYLEDONS

Carpels not on a gynophore, but sometimes on an elongated axis:

Torus elongated or cone-like ; annual herbs with entire leaves ; carpels usually very numerous
Ranunculaceae

Torus flat or concave ; carpels few:

Carpels the same number as the petals

Crassulaceae

Carpels fewer than the petals *Saxifragaceae*

Flowers dioecious ; petals and stamens in 3's or multiples of 3 *Menispermaceae*

Stamens united into a column ; flowers unisexual

Menispermaceae

GROUP 2

Two or more free carpels ; petals present, more or less united

Leaves simple ; flowers dioecious ; seeds sometimes with ruminant endosperm, not arillate ; fruit a drupe ; mostly climbers with soft wood and broad medullary rays *Menispermaceae*

Leaves usually pinnate or unifoliate ; flowers hermaphrodite ; seeds often arillate ; fruit a capsule ; trees, shrubs or climbers

Connaraceae

Leaves 1-7-foliate ; flowers somewhat zygomorphic, hermaphrodite ; fruit a capsule ; seeds not arillate ; trees or shrubs ; leaves often punctate *Rutaceae*

GROUP 3

Two or more free carpels ; petals absent

Trees, shrubs or hard-wooded climbers ; leaves simple or rarely compound ; sepals not or rarely slightly petaloid:

Leaves stipulate:

Stamens free or slightly connate at the base:

Calyx imbricate:

Stipules free from or adnate to the petiole ; fruits acheniolar drupaceous, often included by the tubular calyx ; disk usually present ; flowers hermaphrodite or polygamodioecious *Rosaceae*

Calyx valvate

Sterculiaceae

Stamens united into a column ; anthers in a ring or unequally arranged *Sterculiaceae*

Leaves exstipulate:

Seeds with ruminant endosperm ; stamens numerous, mostly with broad more or less truncate connective ; carpels usually numerous, free in fruit *Annonaceae*

Seeds sometimes with ruminant or uniform endosperm ; stamens definite, often in 3's, with narrow connective ; carpels few, free ; mostly climbers *Menispermaceae*

KEY TO FAMILIES OF DICOTYLEDONS 383

Herbs with radical or alternate leaves (or very soft-wooded climbers with opposite leaves and rather broad medullary rays):

Carpels usually numerous, achenial and 1-seeded in fruit or follicular with several seeds, often with long hairy tails; flowers mostly hermaphrodite; sepals usually petaloid, valvate or imbricate

Ranunculaceae

Carpels mostly few; sepals not petaloid, sometimes rather scarious:

Flowers hermaphrodite; stamens free amongst themselves; leaves alternate:

Carpels in more than 1 whorl; sepals free; style terminal or nearly so

Ranunculaceae

Carpels 1-4; sepals united into a tube; style basal or lateral

Rosaceae

Flowers unisexual; sepals usually biserially imbricate; stamens free or variously connate; carpels mostly 3 or 6; climbers

Menispermaceae

GROUP 4

One carpel or two or more united carpels with parietal placentation; ovary superior; petals present, free from each other

Leaves opposite (to p. 384):

Stamens more or less united into three or more separate bundles; leaves often gland-dotted or with resin canals:

Mostly herbaceous or suffruticose; leaves often with pellucid dots; styles free or nearly so

Hypericaceae

Trees or shrubs; leaves with lines of resin canals and very numerous lateral nerves; stigma sessile or subsessile

Guttiferae

Stamens free or more or less united at the base into not more than two separate bundles (diadelphous), sometimes adnate to a gynophore; leaves not or rarely glandular:

Connective of the anthers produced above the loculi; flowers often somewhat zygomorphic (irregular), the lower petal often gibbous or saccate at the base

Violaceae

Connective of the anthers not produced; flowers usually actinomorphic (regular):

Stamens 6, tetradynamous; sepals 4; petals 4, often clawed; ovary of 2 carpels

Cruciferae

Stamens not tetradynamous, often many:

Stamens more than double the number of the petals:

Ovary stipitate:

Stamens hypogynous

Capparidaceae

Stamens perigynous, inserted on the calyx-tube

Lythraceae

Ovary sessile:

Petals and stamens hypogynous; leaves often gland-dotted

Hypericaceae

Petals and stamens perigynous; leaves not gland-dotted

Samydaceae

384 KEY TO FAMILIES OF DICOTYLEDONS

- Stamens the same or double the number of the petals:
 - Stamens and petals hypogynous ; style 1, divided into as many stigmas as placentas ; no corona *Flacourtiaceae*
 - Stamens and petals perigynous ; no corona present:
 - Stamens not diadelphous ; flowers actinomorphic:
 - Styles free ; seeds with endosperm ; stamens erect in bud:
 - Herbs with fleshy exstipulate leaves ; carpels as many as the petals *Crassulaceae*
 - Shrubs with deciduous bark and thin leaves ; carpels fewer than the petals ; no gynophore *Hydrangeaceae*
 - Mostly climbers with tendrils ; leaves usually stipulate ; ovary on a gynophore *Passifloraceae*
 - Styles united ; seeds without endosperm ; stamens often inflexed in bud *Lythraceae*
 - Stamens diadelphous ; flowers zygomorphic *Papilionaceae*
 - Stamens hypogynous to perigynous ; corona present ; stamens adnate to a gynophore *Passifloraceae*
- Leaves alternate or all radical:
 - Stamens numerous (more than 12) (to p. 386):
 - Filaments connate into a tube or column ; anthers free, small ; petals often valvate ; flowers mostly in heads or dense spikes *Mimosaceae*
 - Filaments connate into separate bundles:
 - Bundles of filaments opposite the sepals *Tiliaceae*
 - Bundles of filaments opposite the petals *Samydaceae*
 - Filaments free or partially adnate to a gynophore, or shortly connate only at the base:
 - Ovary supported on a gynophore *Cappariaceae*
 - Ovary sessile or very nearly so:
 - Anthers horseshoe-shaped ; ovary placentas 2 ; ovules numerous ; stipules caducous, leaving a wide scar ; leaves large ; pedicels often with 5 large glands below the sepals *Bixaceae*
 - Anthers straight or nearly so:
 - Anthers opening by apical pores or short pore-like slits:
 - Seeds hairy ; ovary entire ; leaves digitately nerved or lobed *Cochlospermaceae*
 - Seeds not hairy ; ovary often deeply lobed, especially in fruit ; leaves pinnately nerved *Ochnaceae*
 - Anthers opening by longitudinal slits:
 - Flowers actinomorphic (regular):
 - Fleshy plants, often spiny and with reduced or fleshy leaves ; no stipules ; stigmas often many *Cactaceae*
 - Above characters not associated:
 - Stipules present, sometimes early deciduous, free or adnate to the petiole ; sepals imbricate or valvate ; petals often 5:
 - Corona absent:
 - Ovary of more than 1 carpel, i.e. with 2 or more placentas:
 - Petals and stamens hypogynous:
 - Leaves simple ; sepals at length reflexed or deciduous *Flacourtiaceae*

KEY TO FAMILIES OF DICOTYLEDONS 385

- Leaves mostly pinnate ; sepals not or rarely reflexed, not deciduous
Anacardiaceae
- Petals and stamens perigynous :
 - Sepals persistent, accrescent *Samydaceae*
 - Sepals not accrescent or only very slightly so
Rosaceae
- Ovary of 1 carpel and with 1 placenta ; stamens and petals hypogynous ; sepals persistent, very imbricate
Dilleniaceae
- Corona present *Passifloraceae*
- Stipules absent :
 - Trees, shrubs or woody climbers :
 - Leaves simple :
 - Flowers mostly solitary ; endosperm of seeds ruminant ; stamens and petals hypogynous
Annonaceae
 - Flowers rarely solitary, sometimes spicate-racemose ; endosperm smooth :
 - Ovary wholly superior :
 - Leaves rather small or very small ; flowers often spicate or racemose
Tamaricaceae
 - Leaves rather large ; flowers rarely spicate
Flacourtiaceae
 - Ovary semi-inferior *Samydaceae*
 - Leaves mostly bipinnate ; petals valvate ; calyx tubular, often valvate ; flowers often in heads or spikes
Mimosaceae
 - Herbs :
 - Sepals more than 2 ; juice not milky :
 - Leaves ternately compound ; sepals petaloid ; carpel 1, baccate in fruit
Ranunculaceae
 - Leaves pinnatisect ; sepals not petaloid, 4 ; petals 4, clawed ; ovary of 2 carpels
Cruciferae
 - Sepals 2 ; juice milky ; petals often 4, fugacious, not clawed ; ovary of more than 1 carpel
Papaveraceae
- Flowers zygomorphic (irregular) :
 - Petals and stamens hypogynous ; petals often considerably modified ; ovary of 1 carpel
Ranunculaceae
 - Petals and stamens hypogynous or slightly perigynous ; petals mostly laciniate ; ovary of more than 1 carpel
Resedaceae
 - Petals and stamens perigynous or subperigynous ; petals not laciniate :
 - Fleshy plants with thick or reduced leaves ; ovary of more than 1 carpel
Cactaceae
 - Not fleshy ; leaves not reduced ; ovary of 1 carpel :
 - Odd petal adaxial *Papilionaceae*
 - Odd petal not adaxial *Caesalpinhiaceae*

386 KEY TO FAMILIES OF DICOTYLEDONS

Stamens 12 or fewer:

Stamens 6, four long and two short (tetradynamous); sepals 4;
petals 4; ovary of 2 carpels, often divided by a false septum

Cruciferae

Stamens not as above, rarely 6:

Flowers markedly zygomorphic; stamens with at least one row
alternate with the petals:

Fertile stamens about 2; ovary often supported on a short or
long gynophore:

Ovary of more than 1 carpel *Capparidaceae*

Ovary of 1 carpel (1 placenta); leaves usually pinnate
Caesalpiniaceae

Fertile stamens more than 2:

Fleshy plants with numerous petals *Cactaceae*

Not fleshy:

Herbs or rarely shrubs or trees; anthers often with
produced connective, mostly connivent or connate
around the style *Violaceae*

Herbs, shrubs or trees; anther connective not produced
or only glandular:

Placentas 3; 5 fertile stamens, with the same number
of staminodes *Moringaceae*

Placenta 1:

Odd petal adaxial; corolla of standard, wings and
keel (papilionaceous) *Papilionaceae*

Odd petal not adaxial; corolla not as above; anthers
opening by slits *Caesalpiniaceae*

Odd petal not adaxial; anthers opening by pores
Polygalaceae

Flowers actinomorphic (regular) or nearly so:

Flowers with a distinct corona, this sometimes membranous or
represented by a definite ring of hairs towards the base
of the calyx-tube: ovary of more than 1 carpel

Passifloraceae

Flowers without a corona:

Stamens united with the anthers in a ring around the apex
of the column; leaves not punctate; endosperm often
ruminate *Menispermaceae*

Stamens free or united only at the base or rarely only the
anthers connivent:

Leaves stipulate:

Anthers with the connective produced above the loculi:

Anthers connivent around the style or subsessile

Violaceae

Anthers not connivent around the style

Flacourtiaceae

Anthers without a produced connective:

Staminodes present, sometimes petaloid; stipules
sometimes pectinate *Ochnaceae*

Staminodes absent:

Leaves with numerous very sticky gland-tipped
hairs, mostly circinate in bud; seeds not
carunculate *Droseraceae*

KEY TO FAMILIES OF DICOTYLEDONS 387

- Leaves without sticky hairs, not circinate ; seeds
often carunculate or arillate:
 - Mostly climbers with tendrils *Passifloraceae*
 - Shrubs or trees without tendrils *Flacourtiaceae*
- Leaves exstipulate:
 - Stamens the same number as and opposite the petals:
 - Sepals and petals usually in 3's ; anthers mostly
opening by valves *Berberidaceae*
 - Stamens with one row alternate with the petals:
 - Leaves simple, but sometimes deeply divided:
 - Leaves very small and more or less ericoid *Tamaricaceae*
 - Leaves not small:
 - Leaves digitately lobed *Caricaceae*
 - Leaves pinnately lobed or subdigitately nerved ;
calyx-tube very short ; stamens hypogynous *Pittosporaceae*
 - Leaves compound:
 - Flowers in heads or dense spikes ; petals valvate ;
ovary of 1 carpel ; ovules more than 1 *Mimosaceae*
 - Flowers not in heads or dense spikes ; ovary usually
of more than 1 carpel ; ovule solitary *Anacardiaceae*
 - Flowers racemose ; ovary of 5 carpels with numerous
ovules *Caricaceae*

GROUP 5

One carpel or two or more united carpels with parietal placentation ;
ovary superior ; petals present, more or less united

Stamens free from the corolla-tube (to p. 388):

Ovary composed of more than one carpel:

Stamens numerous, more than twice the number of the
corolla-lobes:

Anthers opening by a longitudinal slit, with broadened truncate
connective ; seeds with copious ruminant endosperm ; shrubs,
trees or climbers with exstipulate simple leaves *Annonaceae*

Anthers without a broadened connective ; fleshy plants with
reduced leaves and often very spiny *Cactaceae*

Anthers without a broadened connective ; not fleshy ; leaves
coriaceous ; flowers spicate-racemose ; petals with induplicate
margins *Samydaceae*

Stamens definite in relation to the corolla-lobes ; anthers opening by
terminal pores or pore ; leaves mostly opposite with parallel
main nerves *Melastomaceae*

Stamens 4, connate at the base or up to the middle ; anthers
opening by a terminal pore ; leaves not parallel-nerved, alternate
Polygalaceae

388 KEY TO FAMILIES OF DICOTYLEDONS

- Stamens 5-12 ; anthers neither appendaged nor opening by pores ;
leaves alternate or fasciculate, exstipulate ; erect trees or shrubs ;
never aquatic:
- Branches with hooks ; climbers *Ancistrocladaceae*
- Branches without hooks:
- Leaves fairly large ; flowers more or less corymbose or
paniculate *Pittosporaceae*
- Leaves very small and scale-like ; flowers in slender spikes or
racemes *Tamaricaceae*
- Ovary composed of a single carpel (usually a legume) ; stamens free
or more usually diadelphous or monadelphous, often 10, rarely
numerous:
- Stamens connate into a sheath, or free ; flowers mostly
hermaphrodite:
- Flowers actinomorphic (regular) ; petals valvate ; calyx gamo-
sepalous or valvate ; leaves usually bipinnate, rarely simply
pinnate or reduced to phyllodes ; flowers often collected into
heads *Mimosaceae*
- Flowers zygomorphic (irregular) or rarely actinomorphic ; sepals
imbricate or rarely valvate ; petals imbricate, the upper
(adaxial) one inside the others ; leaves often pinnate or
bipinnate *Caesalpiniaceae*
- Flowers zygomorphic ; petals imbricate, the upper (adaxial) one
(the standard) outside the others, the lateral two (the wings)
outside the abaxial pair (the keel) which are more or less
united along their lower edges ; leaves simple, digitate or
simply pinnate *Papilionaceae*
- Stamens connate into a column with the anthers in a ring at the
top ; flowers dioecious ; fruit a drupe ; slender climbers
Menispermaceae
- Stamens inserted on the corolla-tube, sometimes near the base:
- Stamens double the number of the corolla-lobes:
- Flowers zygomorphic *Polygalaceae*
- Flowers actinomorphic *Cariaceae*
- Stamens the same number as the corolla-lobes ; corolla actinomorphic
or nearly so:
- Leaves opposite:
- Carpels 2, more or less free ; pollen granular *Apocynaceae*
- Carpels 2, free ; styles separate up to the common thickened
apex ; pollen agglutinated into masses ; corolla with a
corona *Asclepiadaceae*
- Carpels 2, connate into a 1- or 2-locular ovary ; pollen not
agglutinated:
- Stamens 5 ; ovules numerous ; corolla-lobes valvate *Gentianaceae*
- Stamens 4 ; ovules numerous *Bignoniaceae*
- Stamens 4 ; ovules 1-2 in each locus *Verbenaceae*
- Leaves alternate or radical *Gentianaceae*
- Stamens fewer than the corolla-lobes, 4 or 2 ; corolla zygomorphic
or rarely subactinomorphic:
- Ovules numerous on each placenta *Bignoniaceae*
- Ovules 1-2 on each placenta ; stem and branches often 4-sided
Verbenaceae

GROUP 6

One carpel or two or more united carpels with parietal placentation ;
ovary superior ; petals absent

Leaves modified into pitchers ; flowers dioecious ; stamens united into a
column ; ovary 3-4-locular with numerous ovules in each loculus ;
seeds elongate-fusiform ; embryo straight *Nepenthaceae*

Leaves not modified into pitchers:

Stamens 6, 4 long and 2 short (tetradynamous) ; fruits often with
a thin membranous false septum between the placentas ; seeds
without endosperm, with accumbent or incumbent cotyledons ;
sepals usually 4 *Cruciferae*

Stamens rarely 6, and then not tetradynamous:

Stamens more than 1 (to p. 390):

Ovary composed of 1 carpel ; fruit usually a legume:

Stamens more than 4 ; sepals not or rarely valvate:

Stamens 10 or fewer by abortion:

Leaves usually compound ; flowers zygomorphic

Caesalpiniaceae

Leaves mostly simple ; flowers actinomorphic:

Anthers erect in bud

Ulmaceae

Anthers inflexed in bud

Moraceae

Stamens numerous:

Flowers zygomorphic ; fruit mostly a legume *Papilionaceae*

Flowers actinomorphic ; fruit a berry *Flacourtiaceae*

Stamens 4, opposite the valvate calyx-segments *Proteaceae*

Ovary composed of more than 1 carpel ; at least with 2 or more
placentas or more than 1 ovule:

Ovary and fruit stipitate:

Flowers not in catkins:

Stamens more than 4 ; sepals rarely valvate *Capparidaceae*

Stamens 4 ; sepals valvate, often coloured *Proteaceae*

Flowers in catkins

Salicaceae

Ovary sessile:

Flowers without a corona but sometimes with a hypogynous
disk:

Stamens hypogynous or flowers unisexual:

Seeds with endosperm:

Leaves alternate ; trees or shrubs ; stipules small,
caducous or absent *Flacourtiaceae*

Leaves alternate ; more or less herbaceous ; with large
pinnately or digitately nerved leaves ; flowers
paniculate ; no stipules *Papaveraceae*

Seeds without endosperm ; torus not dilated ; fruit a
capsule ; branches leafy *Salicaceae*

Seeds without endosperm ; torus dilated at the back ;
stamens 10-20 ; fruit a berry ; often spiny shrubs
more or less aphyllous *Resedaceae*

Stamens distinctly perigynous:

Anthers inflexed in bud ; staminodes rarely present ;
filaments free *Lythraceae*

Anthers not inflexed in bud ; staminodes often alternating

390 KEY TO FAMILIES OF DICOTYLEDONS

- with the fertile stamens ; filaments free or connate ;
indumentum sometimes stellate *Samydaceae*
- Anthers not inflexed in bud ; no staminodes ; stamens 4,
opposite the valvate sepals *Proteaceae*
- Flowers with a distinct corona, more or less perigynous *Passifloraceae*
- Stamen 1 ; stems articulated ; leaves reduced to scales ; flowers
unisexual, male spicate ; anther inflexed in bud *Casuarinaceae*

GROUP 7

- One carpel or two or more united carpels with parietal placentation ;
ovary inferior ; petals present, free from each other

Flowers hermaphrodite :

- Anthers opening by pores ; leaves mostly opposite with parallel main
nerves ; stamens definite, often double the number of the petals *Melastomaceae*

Anthers not opening by pores :

Ovary-loculi not superposed :

- Stamens numerous, more than twice as many as the petals :

Shrubs or trees with gland-dotted mostly opposite leaves

Myrtaceae

Leaves not gland-dotted, sometimes reduced or fleshy ; fleshy
herbs or shrubs with reduced leaves

Cactaceae

Trees or shrubs

Samydaceae

- Stamens 4-12 ; shrubs or trees ; calyx imbricate or valvate :

Leaves alternate :

Leaves often gland-dotted, not stipulate

Escalloniaceae

Leaves not glandular, mostly stipulate

Grossulariaceae

Leaves opposite, not stipulate

Hydrangeaceae

- Stamens definite ; usually herbs or weak climbers :

Sepals and petals imbricate

Saxifragaceae

Sepals valvate ; petals contorted ; ovary usually 4-locular

Onagraceae

- Ovary-loculi superposed in two series ; leaves opposite or subopposite

Punicaceae

Flowers unisexual :

Leaves gland-dotted ; style simple

Myrtaceae

Leaves not gland-dotted ; styles or stigmas usually 3 :

Stamens numerous ; leaves stipulate ; no tendrils ; ovary closed,
often winged

Begoniaceae

Stamens 3 or 5 ; no stipules ; often with tendrils ; ovary closed

Cucurbitaceae

Stamens 4 to many ; stipules absent ; no tendrils ; ovary often
gaping

Datisceae

GROUP 8

- One carpel or two or more united carpels with parietal placentation ;
ovary inferior ; petals present, more or less united

Stamens numerous ; leaves often gland-dotted, mostly opposite

Myrtaceae

KEY TO FAMILIES OF DICOTYLEDONS 391

Stamens usually definite, rarely numerous, rarely more than twice the number of the corolla-lobes:

Fleshy plants (often) usually with minute leaves; calyx-lobes, petals and stamens numerous; style radiate at the apex

Cactaceae

Above characters never combined; stamens mostly the same number, double or fewer than the petals:

Flowers unisexual; leaves alternate; tendrils often present; stamens mostly 3; anthers often twisted

Cucurbitaceae

Flowers hermaphrodite; leaves opposite or verticillate, without stipules; anthers mostly opening by terminal pores

Melastomaceae

Flowers hermaphrodite, very rarely unisexual; leaves opposite or alternate, often stipulate; anthers not opening by pores, sometimes connivent at the apex:

Leaves with interpetiolar or intrapetiolar stipules; flowers actinomorphic; stamens usually the same number as the corolla-lobes:

Ovules numerous on the walls of the ovary; branches not hooked

Rubiaceae

Ovule solitary; branches hooked

Ancistrocladaceae

Leaves exstipulate (sometimes the leaves anisophyllous, the smaller appearing like a stipule); shrubs; corolla actinomorphic; stamens numerous, with narrow connective; anther-loculi straight

Samydaceae

GROUP 9

**One carpel or two or more united carpels with parietal placentation;
ovary inferior; petals absent**

Leaves gland-dotted, opposite or alternate; stipules absent; stamens numerous; shrubs or trees, rarely herbaceous

Myrtaceae

Leaves not gland-dotted or the leaves reduced to scales; mostly herbs:

Leaves stipulate, stipules sometimes adnate to the petiole:

Flowers hermaphrodite; inflorescence not leaf-opposed; calyx present

Saxifragaceae

Flowers unisexual; stamens usually numerous; ovary often winged

Begoniaceae

Leaves exstipulate; ovary often gaping at the top; stamens 4 - many; calyx not unilateral

Datisceae

Leaves exstipulate; ovary closed at the top; stamens 6 - many; calyx unilateral, coloured; climbers

Aristolochiaceae

GROUP 10

One carpel or two or more united carpels with axile, basal or apical placentation; ovary superior; petals present, free from each other

Perfect stamens, the same number as the petals and opposite to them; leaves alternate or rarely opposite or all radical (to p. 392):

392 KEY TO FAMILIES OF DICOTYLEDONS

Leaves not gland-dotted ; petals and stamens more or less hypogynous or subperigynous ; disk usually conspicuous :

Calyx-lobes or sepals imbricate :

Petals imbricate or biseriately imbricate :

Ovary 1-locular ; ovules basal :

Petals often biglandular towards the base ; ovules few ; leaves simple or compound ; anthers opening by valves

Berberidaceae

Petals not glandular at the base ; anthers opening by longitudinal slits

Primulaceae

Ovary 2-3-locular ; ovules 2 in each loculus, horizontal or pendulous ; stamens 4-5, sometimes about 2 only bearing anthers ; no petaloid staminodes

Sabiaceae

Ovary 1-2-locular ; ovule solitary, pendulous from near the top :

Sepals free or only shortly united

Samydaceae

Sepals united high up ; leaves often crowded ; mostly undershrubs

Thymelaeaceae

Petals valvate, mostly climbers with swollen nodes and leaf-opposed inflorescences

Ampelidaceae

Calyx-lobes valvate :

Disk absent from the flowers :

Trees and shrubs or rarely herbs ; flowers not scapose :

Leaves stipulate ; stamens hypogynous

Sterculiaceae

Leaves exstipulate ; stamens perigynous

Lythraceae

Herbs, mostly with rosettes of leaves ; flowers in scapose inflorescences

Plumbaginaceae

Disk present, perigynous ; leaves mostly stipulate ; ovary 2-4-locular ; ovules erect ; seeds mostly with copious endosperm and large straight embryo

Rhamnaceae

Disk present ; leaves exstipulate

Olaceaceae

Leaves pellucid-punctate :

Leaves simple, without stipules ; ovules numerous ; trees or shrubs ; no tendrils

Myrsinaceae

Leaves mostly compound, usually stipulate ; inflorescence leaf-opposed ; ovules 1-2 in each loculus ; mostly climbers with tendrils

Ampelidaceae

Perfect stamens the same number as the petals and alternate with them or more numerous, very rarely fewer :

Stamens 6, tetradynamous (4 long and 2 short) ; flowers usually actinomorphic (regular) ; petals 4, often clawed ; placentas 2

Cruciferae

Stamens not as above, rarely 6 :

Style basal ; stipules mostly persistent :

Leaves simple ; stamens numerous ; stomata of the leaves usually with special subsidiary cells

Rosaceae

Leaves pinnate ; stamens 10 ; disk large

Simarubaceae

Style or styles terminal or subterminal, sometimes gynobasic :

Flowers markedly zygomorphic (irregular) (to p. 393) :

Stamens definite in number, 12 or fewer :

Lower sepal not spurred ; sepals 5, the inner 2 larger and often petaloid wing-like ; anthers often opening by an apical pore ; seeds mostly with endosperm

Polygalaceae

KEY TO FAMILIES OF DICOTYLEDONS 393

- Lower sepal not spurred ; sepals 4-5 or rarely up to 12, subequal ; anthers opening by longitudinal slits ; seeds mostly with copious endosperm *Saxifragaceae*
- Stamens more than 12 :
 - Stamens and petals hypogynous *Tamaricaceae*
 - Stamens and petals perigynous or epigynous *Rosaceae*
- Flowers actinomorphic or very slightly zygomorphic :
 - Stamens united into more than one separate bundle (phalanges) often opposite the petals :
 - Leaves opposite, often gland-dotted or with resinous lines, exstipulate ; calyx imbricate :
 - Herbs or shrubs ; styles free from the base or nearly so ; flowers hermaphrodite *Hypericaceae*
 - Trees or shrubs ; styles mostly more or less united or stigma one and sessile or subsessile ; flowers mostly unisexual *Guttiferae*
 - Leaves alternate (or if opposite then stipulate) or all radical :
 - Sepals imbricate :
 - Trees or shrubs :
 - Flowers hypogynous :
 - Leaves neither very small nor fleshy *Theaceae*
 - Leaves often small and crowded or fleshy *Tamaricaceae*
 - Flowers perigynous *Samydaceae*
 - Herbs or very small undershrubs :
 - Ovary with a long beak ; carpels 5, completely united *Geraniaceae*
 - Ovary with the carpels only partially united ; carpels 3 *Dilleniaceae*
 - Sepals valvate ; hairs on the leaves, etc., often stellate :
 - Stamens free or monadelphous, or if united into bundles then some sterile *Sterculiaceae*
 - Stamens in separate bundles, all fertile *Tiliaceae*
 - Stamens free or at least not united into several bundles, sometimes more or less united at the base or into one bundle (monadelphous) :
 - Leaves opposite or verticillate or rarely fasciculate, never all radical nor completely reduced (to p. 398) :
 - Leaves compound, rarely unifoliolate and then with a distinctly tumid petiole, sometimes sessile (to p. 394) :
 - Stamens numerous, more than twice the number of the petals *Saxifragaceae*
 - Stamens definite, not more than twice as many as the petals ; disk usually present :
 - Leaves gland-dotted ; disk usually present between the stamens and ovary ; ovary often deeply lobed ; loculi 2-ovuled ; ovules pendulous ; stipules rarely present *Rutaceae*
 - Leaves not gland-dotted, sometimes fleshy :
 - Leaves stipulate (to p. 394) :
 - Ovule pendulous, solitary in each locus ; disk usually within the stamens ; trees or shrubs ; leaves mostly pinnate ; filaments

394 KEY TO FAMILIES OF DICOTYLEDONS

- nude, pilose or with a scale at the base
Simarubaceae
- Ovules ascending ; stamens inserted outside the disk
Staphyleaceae
- Leaves exstipulate :
 - Stamens with free filaments, mostly twice as many as the petals :
 - Leaves digitately 3-foliolate, sessile
Saxifragaceae
 - Leaves pinnate, stalked :
 - Ovules mostly 2 in each loculus *Burseraceae*
 - Ovule 1 in each loculus *Simarubaceae*
 - Stamens with more or less connate filaments, often double the number of the petals
Meliaceae
 - Stamens free, fewer than the petals ; ovules 2 or rarely up to 8
Oleaceae
 - Stamens as many as the petals, free ; ovules numerous in each loculus, at least more than 2
Staphyleaceae
 - Stamens as many as or more than the petals ; ovules 2 in each loculus, collateral ; ovary compressed contrary to the septum
Aceraceae
- Leaves simple, but sometimes deeply and variously divided :
 - Ovary stipitate on a gynophore ; stamens usually numerous, mostly more than twice as many as the petals, or if fewer then leaves gland-dotted ; seeds without endosperm or very little ; petals often clawed :
 - Leaves not gland-dotted :
 - Ovules on the walls or on the intrusive septa
Capparidaceae
 - Ovules on the central axis or from the base of the ovary
Caryophyllaceae
 - Leaves gland-dotted
Rutaceae
 - Ovary sessile or rarely very slightly stipitate :
 - Stamens more than twice as many as the petals (to p. 395) :
 - Calyx imbricate or calyptrate (to p. 395) :
 - Sepals mostly 2, caducous ; petals 4, often crumpled in bud ; filaments free
Papaveraceae
 - Sepals more than 2, mostly persistent ; petals usually 5 :
 - Stipules absent :
 - Stamens united into 5 bundles which are connate nearly to the top ; style single
Hypericaceae
 - Stamens free or united into a mass ; flowers usually dioecious or polygamous
Guttiferae

KEY TO FAMILIES OF DICOTYLEDONS 395

- Stipules present:
 - Leaves pinnately nerved *Theaceae*
 - Leaves with 3 or more longitudinally parallel nerves *Melastomaceae*
- Calyx valvate:
 - Stamens free or very shortly connate at the base:
 - Stamens not inflexed in bud:
 - Stipules paired, not interpetiolar *Tiliaceae*
 - Stipules single, interpetiolar *Rhizophoraceae*
 - Stamens inflexed in bud:
 - Leaves stipulate; indumentum often stellate *Euphorbiaceae*
 - Leaves exstipulate; indumentum rarely stellate:
 - Flowers sometimes large and showy, clawed; ovary few-locular *Lythraceae*
 - Flowers with small sessile petals; ovary many-locular *Sonneratiaceae*
 - Stamens monadelphous or in fascicles opposite the petals, the latter contorted or imbricate; leaves usually stipulate; hairs often stellate *Sterculiaceae*
 - Stamens not more than twice as many as the petals:
 - Trees, shrubs or woody climbers (to p. 397):
 - Leaves stipulate, sometimes stipules rudimentary or of hairs (to p. 396):
 - Stipules intrapetiolar, often connivent into one or adnate to the petiole:
 - Sepals not glandular outside and not accrescent in fruit; hairs not medifixed *Erythroxylaceae*
 - Sepals usually glandular outside or accrescent in fruit; hairs medifixed; leaves often biglandular at the base *Malpighiaceae*
 - Stipules not intrapetiolar, sometimes rudimentary:
 - Disk absent or inconspicuous or of separate glands; calyx often glandular:
 - Stamens free or shortly united only at the base:
 - Calyx mostly with a pair of glands outside; trees, shrubs or climbers; filaments of stamens without a scale *Malpighiaceae*
 - Calyx not glandular; anther-loculi back to back; trees or shrubs; filaments without a scale; petals 4; stamens 4 *Salvadoraceae*
 - Stamens united into a long tube; sepals not glandular; ovary 5-locular with 2 ovules in each; calyx valvate *Rhizophoraceae*

396 KEY TO FAMILIES OF DICOTYLEDONS

- Disk present, conspicuous ; calyx not glandular:
 - Flowers hermaphrodite:
 - Stamens inserted on or below the margin of the disk ; filaments subulate:
 - Stamens 3-5 *Celastraceae*
 - Stamens 8-10 *Rhizophoraceae*
 - Stamens usually 3, inserted on the disk ; filaments flattened or connivent, often adnate to the ovary *Hippocrateaceae*
 - Flowers unisexual ; ovules pendulous from the apex of the loculus:
 - Seeds often carunculate ; flowers rarely in heads *Euphorbiaceae*
 - Seeds not carunculate ; flowers arranged in dense heads ; hairs stellate *Hamamelidaceae*
- Leaves exstipulate or stipules gland-like:
 - Stamens united into a tube:
 - Stamens more than 4 ; flowers hermaphrodite *Meliaceae*
 - Stamens 4 ; flowers unisexual *Guttiferae*
 - Stamens free or very shortly united only at the base:
 - Anthers opening at the apex by a pore ; stamens as many as or twice as many as the petals *Melastomaceae*
 - Anthers opening by slits lengthwise:
 - Ovules numerous in each loculus:
 - Petals and stamens hypogynous ; flowers hermaphrodite *Pittosporaceae*
 - Petals and stamens hypogynous ; flowers unisexual *Guttiferae*
 - Petals and stamens perigynous ; flowers hermaphrodite *Lythraceae*
 - Ovules few in each loculus:
 - Sepals 2-glandular outside ; hairs (when present) on the leaves medifixed ; shrubs or climbers:
 - Fruits usually winged ; styles often 3 *Malpighiaceae*
 - Fruits drupaceous ; style one *Simarubaceae*
 - Sepals not glandular ; hairs not medifixed:
 - Ovules pendulous from the apex of the loculi:
 - Sepals imbricate or open:
 - Sepals free or calyx-tube very short;

KEY TO FAMILIES OF DICOTYLEDONS 397

- Stamens hypogynous:
 - Petals imbricate *Linaceae*
 - Petals valvate *Icacinaceae*
- Stamens perigynous *Escalloniaceae*
- Sepals connate into a long or rather long tube *Thymelaeaceae*
- Sepals valvate *Combretaceae*
- Ovules erect or ascending from the base of the loculi:
 - Calyx imbricate;
 - Filaments subulate or filiform:
 - Leaves mostly palmately lobed, or if not so then disk absent; ovary and fruit compressed contrary to the septum *Aceraceae*
 - Leaves pinnately lobed; disk present:
 - Flowers hermaphrodite *Celastraceae*
 - Flowers dioecious or polygamous *Guttiferae*
 - Filaments flattened *Hippocrateaceae*
 - Calyx valvate; stamens 3-5; style short:
 - Leaves not gland-dotted:
 - Sepals free or nearly so *Anacardiaceae*
 - Sepals united into a long tube; the 2 posticous petals often larger than the others *Lythraceae*
 - Leaves gland-dotted *Rutaceae*
- Herbs, sometimes slightly woody at the base:
 - Ovary incompletely septate with free-central or basal placentation; leaves mostly stipulate:
 - Sepals the same number as the petals, 3-5, free or connate; petals 3-5, often clawed *Caryophyllaceae*
 - Sepals the same number as the petals but often with as many accessory lobes, connate into a tube; stamens inflexed in bud *Lythraceae*
 - Ovary completely septate:
 - Leaves with 3 or more longitudinally parallel nerves; anthers usually appendaged and opening by a terminal pore *Melastomaceae*
 - Leaves not as above; anthers opening by longitudinal slits *Lythraceae*

398 KEY TO FAMILIES OF DICOTYLEDONS

Leaves alternate or all radical:

Stamens more than twice the number of the sepals or petals
(to p. 400):

Sepals valvate or open in bud:

Anthers 2-locular:

Stamens free or slightly united only at the base:

Petals and stamens hypogynous or flowers
unisexual:

Flowers hermaphrodite; indumentum often
stellate *Tiliaceae*

Flowers unisexual; indumentum rarely stellate
Euphorbiaceae

Petals and stamens perigynous or epigynous:

Leaves stipulate; stipules mostly paired;
ovary 2-locular; styles subulate, free

Hamamelidaceae

Leaves exstipulate:

Anthers inflexed in bud; calyx tubular
Lythraceae

Anthers erect in bud:

Leaves simple; wood not resinous:

Ovary incompletely septate, wholly
superior *Olacaceae*

Ovary completely septate, partly
inferior *Styracaceae*

Leaves compound or unifoliolate; wood
resinous *Anacardiaceae*

Stamens more or less united into a tube or into
bundles, hypogynous; indumentum usually
stellate *Sterculiaceae*

Anthers 1-locular; stamens monadelphous; calyx with
or without an epicalyx:

Trees or rarely shrubs; leaves digitately compound
or simple; carpels not or very rarely splitting
away from the central axis in fruit

Bombacaceae

Mostly herbs; leaves simple; carpels often splitting
away from the central axis or becoming free
in fruit *Malvaceae*

Sepals imbricate or rarely completely connate or calyp-
trate or cupulate:

Petals and stamens perigynous:

Leaves stipulate:

Ovary with usually more than 2 carpels or some-
times only one; flowers not or very rarely
capitate *Rosaceae*

Ovary of 2 carpels; flowers often capitate
Hamamelidaceae

Leaves exstipulate:

Stamens free from the petals:

Flowers not capitate:

Petals not crumpled in bud; ovules pendulous
from the apex of the loculi:

KEY TO FAMILIES OF DICOTYLEDONS 399

- Leaves stipulate *Rhizophoraceae*
- Leaves without stipules *Samydaceae*
- Petals often crumpled in bud ; ovules basal
or from the inner angle of the loculus ;
sepals valvate *Lythraceae*
- Flowers capitate, asymmetric ; involucre
coloured *Hamamelidaceae*
- Stamens inserted on the base of the petals *Styracaceae*
- Petals and stamens more or less hypogynous or flowers
unisexual ; disk often present:
- Trees, shrubs or woody climbers (to p. 400):
- Leaves compound or rarely unifoliolate and then
with a tumid petiole:
- Leaves pinnate ; petals not calyptrate:
- Ovule ascending:
- Leaves gland-dotted ; style or styles central *Rutaceae*
- Leaves rarely gland-dotted ; styles or
stigmas often separated:
- Wood resinous *Anacardiaceae*
- Wood not resinous, not bitter *Sapindaceae*
- Wood not resinous, very bitter *Simarubaceae*
- Ovule or ovules pendulous:
- Stamens free ; wood with resin ducts *Anacardiaceae*
- Stamens more or less free from one another ;
wood without resin ducts *Simarubaceae*
- Stamens united into a tube *Meliaceae*
- Leaves simple:
- Leaves stipulate:
- Flowers unisexual:
- Disk present *Euphorbiaceae*
- No disk *Flacourtiaceae*
- Flowers hermaphrodite:
- Torus enlarged after flowering ; ovary
mostly deeply lobed, the carpels
becoming separated in fruit ; anthers
often opening by pores *Ochnaceae*
- Torus not enlarged:
- Ovary stipitate ; sepals more or less
connate into a tube *Capparidaceae*
- Ovary sessile ; sepals usually free ; sepals
5 ; no staminodes:
- Calyx enlarged and wing-like in fruit:
- Flowers mostly rather small and not
showy ; petals much contorted *Dipterocarpaceae*
- Flowers showy ; ovary 1-locular with
a basal placenta *Ochnaceae*

400 KEY TO FAMILIES OF DICOTYLEDONS

- Calyx not enlarged ; leaves digitately lobed ; flowers handsome ; anthers opening by short pore-like confluent slits at the apex ; petals imbricate or slightly contorted
Cochlospermaceae
 - Leaves not stipulate:
 - Ovary and fruit stipitate *Cappariaceae*
 - Ovary and fruit not stipitate:
 - Seeds arillate ; ovary composed of 1 carpel ; leaves mostly with very prominent pinnately parallel lateral nerves ; stamens usually persistent
Dilleniaceae
 - Seeds not arillate ; ovary usually composed of 2 or more carpels:
 - Ovary 1-locular, composed of 1 carpel:
 - Stamens more than 10, free:
 - Leaves pellucid-punctate, rather large and coriaceous
Winteraceae
 - Leaves usually very small and crowded
Tamaricaceae
 - Ovary 2- or more-locular *Theaceae*
 - Herbs, rarely somewhat woody at the base:
 - Leaves neither sticky, glandular, setose-ciliate, nor modified into pitchers:
 - Anthers opening by longitudinal slits:
 - Stamens quite free from one another:
 - Sepals more than 2 *Ranunculaceae*
 - Sepals 2 *Portulacaceae*
 - Stamens connate at the base ; leaves pinnate
Oxalidaceae
 - Anthers opening by a short pore-like terminal slit
Cochlospermaceae
 - Leaves very sticky, glandular or ciliate with setose teeth, not modified into pitchers
Droseraceae
 - Stamens definite in number in relation to the sepals or petals, often the same number or twice as many or fewer:
 - Leaves compound, rarely unifoliolate and then with a distinctly tumid petiole (to p. 401):
 - Stamens united into a tube ; leaves pinnate or rarely unifoliolate ; leaves exstipulate
Meliaceae
 - Stamens free or united only at the base:
 - Leaves stipulate:
 - Herbaceous or slightly woody ; leaves digitately or pinnately compound
Oxalidaceae
 - Trees, shrubs or climbers:
 - Ovules pendulous ; stipules convolute, axillary, often very long ; leaves mostly simple
Simarubaceae

KEY TO FAMILIES OF DICOTYLEDONS 401

- Ovules ascending; leaves compound; habit often climbing; stipules lateral
Sapindaceae
- Leaves exstipulate:
 - Leaves gland-dotted *Rutaceae*
 - Leaves not gland-dotted:
 - Ovules pendulous from towards the apex of the loculi:
 - Ovules 8-12, 2-seriate; flowers small, paniculate *Meliaceae*
 - Ovules solitary or collateral:
 - Ovary of more than 1 carpel; wood mostly resinous *Burseraceae*
 - Ovary of more than 1 carpel; wood with bitter bark but not resinous *Simarubaceae*
 - Ovary of 1 carpel; wood resinous *Anacardiaceae*
 - Ovules ascending or horizontal:
 - Herbs with sensitive leaves *Oxalidaceae*
 - Trees or shrubs:
 - Ovules mostly 2 in each loculus, superposed; styles various *Rutaceae*
 - Ovules about 8 in each loculus; style 1 *Meliaceae*
 - Ovules 2 in each loculus, collateral; style simple *Connaraceae*
 - Ovules 1 or more in each loculus, erect or ascending; style simple or divided *Sapindaceae*
 - Ovule 1 in each loculus; style lobed or styles separate; wood with resin ducts *Anacardiaceae*
- Leaves simple, rarely completely reduced:
 - Anthers opening by valves:
 - Ovary composed of 2 carpels; stipules often present, mostly paired; flowers often capitate *Hamamelidaceae*
 - Ovary composed of 1 carpel; stipules absent *Lauraceae*
 - Anthers opening by apical pores:
 - Leaves with 3 or more longitudinally parallel main nerves; connective of the anthers often produced at the base *Melastomaceae*
 - Leaves pinnately nerved or nerveless:
 - Ovary deeply lobed; torus enlarging in fruit and the carpels often becoming separate; ovules 1-2 in each loculus *Ochnaceae*
 - Ovary not deeply lobed; torus not enlarged:
 - Ovules several in each loculus or in the ovary; leaves narrow *Pittosporaceae*
 - Ovule usually solitary; leaves very narrow; not glandular *Polygalaceae*

402 KEY TO FAMILIES OF DICOTYLEDONS

Anthers opening by slits lengthwise:

Shrubs or trees (to p. 404):

Leaves stipulate (to p. 403):

Calyx persistent and wing-like in fruit ; leaves
often with prominent parallel lateral nerves ;
petals contorted *Dipterocarpaceae*

Calyx not wing-like in fruit ; petals rarely contorted:

Flowers unisexual:

Disk absent ; petals not bilobed

Flacourtiaceae

Disk present ; petals bilobed *Chailletiaceae*

Disk present:

Stipules conspicuous, persistent

Euphorbiaceae

Stipules very inconspicuous, caducous

Celastraceae

Flowers hermaphrodite:

Stamens perigynous, inserted on the
calyx-tube:

Ovary 1-locular, composed of one carpel

Rosaceae

Ovary 2-locular, composed of 2 or more
carpels *Hamamelidaceae*

Stamens hypogynous or inserted on or at
the base of a disk:

Stipules axillary, convolute in bud, often
very long:

Petals not appendaged inside

Simarubaceae

Petals appendaged inside

Erythroxylaceae

Stipules not axillary:

Disk absent, or torus sometimes enlarging in fruit but not glandular:

Stamens 10, in 2 series ; hairs of
the leaves when present not
medifixed ; petiole not glandular

Erythroxylaceae

Stamens 10, in 1 series ; hairs of
leaves often medifixed ; petiole
often glandular like the sepals

Malpighiaceae

Stamens usually numerous ; hairs of
leaves when present not medifixed ; petiole not glandular

Ochnaceae

Disk present, annular or of separate
glands:

Petals entire or emarginate ; ovules
erect *Celastraceae*

Petals often deeply lobed ; ovules
pendulous *Chailletiaceae*

KEY TO FAMILIES OF DICOTYLEDONS 403

Leaves exstipulate:

Stamens united into a tube *Meliaceae*

Stamens free or connate only at the base:

Stamens hypogynous or very slightly perigynous (to p. 404):

Stamens double the number of the petals or fewer only by the abortion of some anthers (to p. 403):

Sepals usually with two large glands outside; hairs of leaves medifixed; ovary 3-locular, with 1 ovule in each loculus; seeds without endosperm; fruit often winged *Malpighiaceae*

Sepals not glandular; hairs rarely medifixed:

Ovary 1-locular:

Ovary of 1 carpel; torus forming a stipe *Anacardiaceae*

Ovary of more than 1 carpel; leaves very small; flowers spicate-racemose *Tamaricaceae*

Ovary completely 2- or more-locular (or nearly completely 5-locular):

Disk present; leaves not gland-dotted; petals mostly valvate:

Flowers hermaphrodite *Olacaceae*
Flowers polygamo-dioecious

Sapindaceae

Disk present, often intrastaminal; leaves gland-dotted *Rutaceae*

Stamens the same number as the petals or fewer:

Disk absent; flowers polygamous, axillary, solitary or fasciculate:

Ovules numerous; anthers opening lengthwise or by apical pores; style simple; embryo minute in copious endosperm

Pittosporaceae

Ovules 1-2, pendulous:

Petals imbricate or contorted, clawed; anthers opening by slits

Linaceae

Petals imbricate, not clawed; anthers opening by an apical pore

Theaceae

Petals imbricate, sessile; anthers opening by slits lengthwise

Aquifoliaceae

Disk present:

Petals valvate; ovules pendulous:

Stamens opposite the petals

Olacaceae

404 KEY TO FAMILIES OF DICOTYLEDONS

- Stamens the same number as and
alternate with the petals
 Icacinaceae
- Petals imbricate or contorted:
Leaves not gland-dotted:
Stamens usually 5:
Ovules 1-3 in each loculus:
Ovule solitary ; wood resinous
 Anacardiaceae
- Ovules mostly 2 in each locu-
lus ; wood not resinous
 Celastraceae
- Ovules several to many
 Pittosporaceae
- Stamens 3, with flattened fla-
ments ; wood not resinous ;
flowers cymose
 Hippocrateaceae
- Leaves gland-dotted *Rutaceae*
- Stamens very distinctly perigynous (from
p. 403):
Leaves with 3 or more longitudinally
parallel main nerves *Melastomaceae*
- Leaves with more or less pinnate nerva-
tion:
Carpels free at the apex ; leaves stipulate
 Hamamelidaceae
- Carpels completely united ; stipules
absent:
Anthers inflexed in bud *Lythraceae*
- Anthers erect in bud:
Petals scale-like, opposite the sepals ;
ovary wholly superior
 Thymelaeaceae
- Petals not scale-like, alternate with
the sepals *Escalloniaceae*
- Herbs, rarely slightly woody at the base:
Leaves covered with dense sticky gland-tipped
hairs or processes or setose-ciliate and bilobed,
stipulate, often circinate in bud *Droseraceae*
- Leaves not glandular:
Leaves stipulate:
Stamens and petals hypogynous ; flowers
unisexual or hermaphrodite:
Flowers hermaphrodite:
Sepals valvate *Tiliaceae*
- Sepals imbricate:
Ovary more or less deeply lobed
 Geraniaceae
- Ovary entire *Linaceae*
- Flowers unisexual *Euphorbiaceae*
- Stamens and petals perigynous ; anthers
inflexed in bud *Lythraceae*

KEY TO FAMILIES OF DICOTYLEDONS 405

Leaves exstipulate:

Petals and stamens hypogynous or very slightly perigynous:

Petals contorted, fugacious, mostly large and conspicuous; embryo straight:

Ovules pendulous; leaves entire or nearly so *Linaceae*

Petals and stamens perigynous:

Seeds with endosperm *Saxifragaceae*

Seeds without endosperm; carpels with a gland or scale at the base; anthers erect in bud *Crassulaceae*

Seeds without endosperm; carpels without a gland or scale; anthers inflexed in bud *Lythraceae*

GROUP 11

One carpel or two or more united carpels with axile, basal or apical placentation; ovary superior; petals present, more or less united

Stamens the same number as and opposite to the corolla-lobes:

Ovules solitary in the whole ovary or in each loculus of the ovary; style often lobed:

Trees or shrubs, often with hard wood:

Flowers dioecious; petals imbricate or valvate; stamens mostly free from the corolla *Ebenaceae*

Flowers hermaphrodite; stamens epipetalous:

Petals imbricate; hairs often stellate or medifixed *Sapotaceae*

Petals valvate; hairs usually simple:

Inflorescence not leaf-opposed; leaves simple *Oleaceae*

Inflorescence leaf-opposed; leaves often compound *Ampelidaceae*

Herbs or climbers:

Corolla-lobes valvate; tendrils often present; inflorescence usually cymose-paniculate, leaf-opposed; leaves usually with the stipules adnate to the petiole *Ampelidaceae*

Corolla-lobes imbricate:

Stamens connate into a column, free from the petals; stipules absent *Menispermaceae*

Stamens more or less adnate to or inserted on the corolla *Plumbaginaceae*

Ovules 2 or more in each loculus; style undivided; placentas often basal:

Trees or shrubs with often gland-dotted leaves; ovules 2 or more in the ovary *Myrsinaceae*

Herbs or climbers with usually compound leaves and leaf-opposed inflorescence *Ampelidaceae*

Herbs often with rosettes of leaves; leaves not gland-dotted *Primulaceae*

KEY TO FAMILIES OF DICOTYLEDONS 407

- Leaves not gland-dotted ; petals usually joined high up:
Style single with often a large more or less capitate stigma:
Pollen granular ; leaves stipulate or sheathing at the base:
Trees or shrubs leaves often stipulate *Loganiaceae*
Mostly herbs or scramblers ; leaves not stipulate *Solanaceae*
Pollen agglutinated in wax-like masses ; corolla with a corona ; leaves exstipulate *Asclepiadaceae*
Pollen granular ; corolla without a corona ; leaves exstipulate:
Corolla-lobes contorted or rarely valvate *Apocynaceae*
Corolla-lobes imbricate:
Leaves not verticillate *Scrophulariaceae*
Leaves verticillate *Verbenaceae*
Styles with more than 1 separate stigmas:
Stamens double the number of the corolla-lobes ; petals united only at the base:
Mostly herbaceous ; flowers hermaphrodite *Lythraceae*
Trees or shrubs ; flowers dioecious *Ebenaceae*
Stamens the same number as the corolla-lobes:
Rudimentary stipules often present ; stamens and corolla-lobes 4 *Salvadoraceae*
Stipules absent:
Style gynobasic *Boraginaceae*
Style terminal:
Trees or shrubs:
Ovules numerous in each loculus, or if solitary then corolla-lobes valvate *Loganiaceae*
Ovules 1-2 in each loculus ; corolla-lobes imbricate *Verbenaceae*
Herbs or herbaceous climbers:
Ovary imperfectly locular by the intrusive parietal placentas *Gentianaceae*
Ovary perfectly locular with axile placentas *Solanaceae*
Leaves alternate or all radical or reduced to scales:
Leafless parasites destitute of chlorophyll ; flowers hermaphrodite *Convolvulaceae*
Not parasitic or rarely so ; leaves more or less green and normally developed:
Leaves stipulate, stipules sometimes soon falling off:
Leaves densely covered with viscid gland-tipped hairs, mostly all radical ; often stemless herbs ; flowers mostly in simple circinate cymes ; placentas sub-basal ; styles 3-5, mostly free *Droseraceae*
Leaves not as above:
Flowers unisexual ; petals not bifid ; ovary usually 3-lobed and 3-locular ; calyx not wing-like in fruit *Euphorbiaceae*

408 KEY TO FAMILIES OF DICOTYLEDONS

Flowers hermaphrodite or unisexual ; petals bifid or bilobed ; calyx not wing-like in fruit

Chaillotiaceae

Flowers hermaphrodite ; petals not bilobed ; ovary 1-locular, 1-ovulate ; stamens 5 or 10 ; calyx wing-like in fruit

Ancistrocladaceae

Leaves exstipulate :

Stamens hypogynous or perigynous, free from the corolla or slightly adnate to its base (to p. 409) :

Anthers opening by terminal pores, often with appendages ; calyx persistent, sometimes petaloid ; corolla-lobes contorted or imbricate ; woody plants

Ericaceae

Anthers opening by longitudinal slits :

Stamens 4-6 :

Leaves gland-dotted ; ovary mostly deeply lobed ; petals connivent by their claws ; disk usually conspicuous between the stamens and ovary

Rutaceae

Leaves not gland-dotted ; ovary mostly entire :

Petals only slightly united at the base :

Disk present in the flowers, usually conspicuous :

Corolla-segments valvate ; ovules 2-5 in each loculus :

Stamens opposite the petals or more numerous than them

Oleaceae

Stamens the same number as and alternate with the petals

Icacinaceae

Corolla-segments imbricate ; ovules numerous ; sepals imbricate :

Leaves not small and ericoid

Pittosporaceae

Leaves small and ericoid

Tamaricaceae

Disk absent, or if present, adherent to the ovary :

Ovules numerous ; sepals imbricate ; not epiphytic

Pittosporaceae

Ovules 1-2 in each loculus ; indumentum not stellate or lepidote ; calyx-lobes imbricate ; leaves simple

Aquifoliaceae

Ovules 2 in each loculus, collateral, ascending ; leaves pinnate

Connaraceae

Ovules few in each loculus ; indumentum often stellate or lepidote ; calyx-lobes valvate or open

Styracaceae

Petals united high up ; sometimes free at the base :

Herbs ; not aquatic

Campanulaceae

Trees or shrubs

Burseraceae

KEY TO FAMILIES OF DICOTYLEDONS 409

- Stamens more than 6:
 - Stamens connate into a tube *Meliaceae*
 - Stamens free or slightly connate only at the base:
 - Disk absent ; corolla long and tubular *Ebenaceae*
 - Disk present, or if inconspicuous or absent then the corolla-tube very short:
 - Leaves gland-dotted, often compound or unifoliolate *Rutaceae*
 - Leaves not gland-dotted, simple or very rarely compound:
 - Disk present in the flowers:
 - Leaves well developed, not small and ericoid:
 - Leaves simple ; bark not bitter *Olacaceae*
 - Leaves compound or unifoliolate ; bark usually bitter *Simarubaceae*
 - Leaves small and ericoid ; flowers in spikes or racemes *Tamaricaceae*
 - Disk absent:
 - Ovules 1-2 in each loculus ; indumentum not stellate ; calyx-lobes imbricate:
 - Calyx-tube very short *AQUIFOLIACEAE*
 - Calyx-tube long and slender *Thymelaeaceae*
 - Ovules few in each loculus ; indumentum often stellate or lepidote ; calyx-lobes valvate or open *Styracaceae*
 - Stamens inserted on the corolla-tube or in a column adnate to the stigma (from p. 408):
 - Style gynobasic:
 - Style 1 ; fruit composed of pyrenes or nutlets *Boraginaceae*
 - Styles 2 ; fruit mostly capsular *Convolvulaceae*
 - Style not gynobasic, terminal:
 - Corolla valvate or plaited in bud (in the latter case the limb may be somewhat twisted but not truly imbricate):
 - Ovules 1-4 in each ovary-loculus:
 - Ovules basal, erect *Convolvulaceae*
 - Ovules pendulous from the top of the ovary *Icacinaeae*
 - Ovules numerous in each ovary-loculus *Gentianaceae*
 - Flowers with a corona ; pollen agglutinated in wax-like masses *Asclepiadaceae*
 - Flowers without a corona ; pollen not agglutinated in wax-like masses *Solanaceae*
 - Corolla imbricate or contorted in bud:
 - Pollen agglutinated in wax-like masses *Asclepiadaceae*
 - Pollen not agglutinated in wax-like masses *Apocynaceae*

410 KEY TO FAMILIES OF DICOTYLEDONS

Herbs:

Style undivided or very shortly lobed ; lower
leaves opposite *Gentianaceae*

Style undivided ; stigmas terminal, small or
more or less dilated ; all the leaves
alternate *Solanaceae*

Trees or shrubs ; fruit a pyrene or nut

Boraginaceae

Stamens fewer than the corolla-lobes ; leaves mostly opposite
(from p. 406):

Flowers actinomorphic:

Stamens more than 1:

Ovules numerous ; corolla not dry and scarious:

Herbs:

Corolla-lobes induplicate or contorted-plicate

Solanaceae

Corolla-lobes imbricate

Scrophulariaceae

Shrubs ; stamens 2

Oleaceae

Ovules 1-2 in each loculus of the ovary ; corolla not
scarious:

Corolla-lobes not more than the calyx-lobes:

Corolla-lobes quite equal ; ovules mostly pendulous

Oleaceae

Corolla-lobes slightly unequal or limb oblique ; ovules
erect

Verbenaceae

Corolla-lobes about 3 times as many as the calyx-lobes

Sapotaceae

Stamen 1 ; corolla articulating above the base ; flowers in
corymbose panicles

Loganiaceae

Flowers zygomorphic:

Ovules numerous in the whole ovary or in each loculus of the
ovary, or if 2 then superposed (to p. 411):

Anthers mostly free from each other ; ovary completely
2-locular, with the placentas on the septum ; loculi
ad- and abaxial

Scrophulariaceae

Anthers often coherent ; ovary imperfectly 2-locular by the
variously intrusive parietal placentas, the latter placed
right and left of the floral axis

Gesneriaceae

Anthers free but connivent ; ovary mostly 2-locular and then
the loculi ad- and abaxial (antero-posterior) ; leaves often
compound ; woody plants, very rarely herbaceous ; seeds
often winged, transverse

Bignoniaceae

Anthers often connivent in pairs ; ovary 1-4-locular ; fruit
usually with a hard endocarp ; seeds not winged:

Herbs with vesicular glands ; leaves opposite or alternate ;
fruit sometimes prickly ; disk mostly inconspicuous

Pedaliaceae

Herbs or rarely shrubs with tumid nodes and opposite or
verticillate leaves ; seeds inserted on hardened out-
growths from the central placentas ; leaves often
prominently marked with cystoliths ; valves of the
capsule opening elastically from the apex ; disk
cupular or annular

Acanthaceae

KEY TO FAMILIES OF DICOTYLEDONS 411

- Shrubs ; nodes not tumid ; leaves alternate ; 2 inner lobes of the corolla broadly emarginate or bifid ; fruit a drupe ; disk subannular or lobed *Chaillotiaceae*
- Ovule solitary in each loculus of the ovary, or if 2 then collateral:
- Leaves opposite or verticillate:
- Ovary entire ; style terminal:
- Filaments free from each other *Verbenaceae*
- Filaments forming a sheath split on its upper edge *Polygalaceae*
- Ovary 4-lobed ; style gynobasic *Labiatae*
- Leaves alternate *Polygalaceae*

GROUP 12

One carpel or two or more united carpels with axile, basal or apical placentation ; ovary superior ; petals absent

Hermaphrodite or male (and often the female) flowers without a calyx (perianth) (to p. 412):

- Leaves radical, palminerved ; flowers in a slender spike ; carpel 1 ; ovule 1, erect from the base of the loculus ; herb with creeping rhizome *Berberidaceae*

Leaves not all radical ; above characters not associated:

- Trees or shrubs with whorled scale-like leaves *Casuarinaceae*

Trees, shrubs or herbs with normally developed leaves:

Leaves stipulate ; stipules sometimes adnate to the petiole:

Ovary 1-locular:

- Herbs or shrubs ; leaves usually alternate ; flowers in dense spikes ; petiole not dilated and not enclosing the young bud *Piperaceae*

Trees or shrubs with alternate leaves ; flowers minute on a common open receptacle, the fruit becoming immersed in it *Moraceae*

Large trees ; leaves alternate, palmately nerved and lobed, the dilated petiole enclosing the young bud *Platanaceae*

Ovary 2- or more-locular ; leaves alternate:

Ovules 1-2 in each loculus of the ovary ; stipules rarely spinulose, often caducous:

- Flowers various, sometimes in an involucre margined with fleshy glands ; seeds usually with copious endosperm ; ovary usually 2-3- or more-locular *Euphorbiaceae*

Male flowers in catkins or slender spikes ; endosperm absent from the seeds ; ovary 2-6-locular:

Fruit with a cupular involucre or enclosed by the latter *Fagaceae*

Fruit cone-like, with imbricate scales *Betulaceae*

Ovules numerous ; stipules not spinulose ; large trees ; leaves not plicately nerved *Hamamelidaceae*

Leaves without stipules:

Trees or shrubs with hard wood:

Flowers in a cyathium *Euphorbiaceae*

412 KEY TO FAMILIES OF DICOTYLEDONS

Flowers not in a cyathium:

Leaves aromatic, often glandular ; flowers in dense spikes ;
mostly swamp plants ; leaves simple *Myricaceae*

Leaves not aromatic, pinnate ; not swamp plants
Oleaceae

Herbs, sometimes slightly woody at the base:

Ovary 1-locular:

No stinging hairs ; stems not fibrous ; epidermal cells
without cystoliths *Chenopodiaceae*

No stinging hairs ; stems not fibrous ; flowers minute,
usually densely spicate ; epidermal cells often with
cystoliths *Piperaceae*

Stinging hairs often present ; stems often fibrous ; epidermal
cells mostly with prominent cystoliths *Urticaceae*

Ovary 2-3-locular ; flowers much reduced, often arranged in
a cyathium with glands on the margin *Euphorbiaceae*

All the flowers (or at any rate the male) with a calyx, sometimes minute
or petaloid and long tubular:

Leaves opposite or verticillate, never all radical (to p. 414):

Leaves stipulate (to p. 413):

Stamens more than twice the number of the sepals:

Flowers unisexual *Euphorbiaceae*

Flowers hermaphrodite:

Sepals free or nearly so ; stamens hypogynous *Geraniaceae*

Sepals united into a tube ; stamens inserted on the calyx-tube,
more or less perigynous *Rosaceae*

Stamens definite, up to twice as many as the sepals:

Stamens the same number as and alternate with the sepals,
4 or 5:

Ovules 1-2 *Rhamnaceae*

Ovules numerous *Crypteroniaceae*

Stamens the same number as and opposite the sepals or more
numerous or fewer:

Ovary with free-central placentation ; ovules usually several
to numerous *Caryophyllaceae*

Ovary with axile, basal or apical placentation:

Flowers arranged in an involucre (cyathium) margined with
fleshy often more or less semilunar glands ; male flower
with only one stamen, jointed about the middle ; ovary
often stipitate, mostly 3-locular *Euphorbiaceae*

Flowers not as above ; stamens usually more than 1 ; ovary
mostly sessile:

Flowers unisexual (to p. 413):

Ovary 2- or more-locular *Euphorbiaceae*

Ovary 1-locular:

Ovule erect:

Filaments inflexed in bud ; mostly herbaceous
plants with fibrous stems and sometimes
stinging hairs ; juice not milky *Urticaceae*

Filaments not inflexed in bud ; mostly trees and
shrubs, very rarely herbs ; juice mostly
milky ; flowers often minute and arranged on
or inside an enlarged 'receptacle' *Moraceae*

KEY TO FAMILIES OF DICOTYLEDONS 413

Ovule pendulous:

Filaments not inflexed in bud:

Fruit a drupe ; flowers monoecious or subdioecious *Ulmaceae*

Fruit a small dry achene ; flowers dioecious

Cannabaceae

Filaments erect or inflexed in bud *Moraceae*

Flowers hermaphrodite:

Sepals free or nearly so ; stamens more or less hypogynous ; ovary 3-10-locular *Geraniaceae*

Sepals free or nearly so ; stamens hypogynous or perigynous ; ovary 1-locular *Polygonaceae*

Sepals connate into a tube ; stamens perigynous ; ovary 1-5-locular *Rosaceae*

Leaves without stipules:

Ovary and fruit compressed contrary to the septum, 2-locular ; trees or shrubs with perulate buds ; leaves simple or palmately lobed or pinnately foliolate ; flowers andromonoecious or dioecious *Aceraceae*

Ovary if compressed then not contrary to the septum or septa:

Ovules 2 or more in each loculus of the ovary or in a 1-locular ovary:

Flowers hermaphrodite:

Shrubs or trees with woody branches:

Calyx more or less spreading, or not tubular ; large disk often present *Celastraceae*

Calyx tubular, lobes valvate ; disk absent or inconspicuous:

Ovary 2-4-locular ; calyx not or rarely petaloid, often with accessory lobes *Lythraceae*

Ovary many-locular *Sonneratiaceae*

Ovary 4-locular ; calyx petaloid, lobes valvate ; stamens opposite the lobes ; flowers often in heads *Proteaceae*

Herbs:

Sepals united into a tube ; stamens perigynous

Lythraceae

Sepals free or nearly so ; stamens usually hypogynous

Amarantaceae

Flowers unisexual:

Leaves digitately compound *Euphorbiaceae*

Leaves simple ; ovary 3-locular *Buxaceae*

Ovule solitary in each loculus of the ovary or in a 1-locular ovary:

Stamens circinate involute in bud ; calyx usually long-tubular, often coloured ; bracts sometimes petaloid

Nyctaginaceae

Stamens sometimes inflexed but not circinate in bud ; calyx often scarious but rarely petaloid ; bracts often scarious:

Flowers not arranged in a cyathium ; mostly hermaphrodite:

Trees, shrubs or undershrubs with woody stems ; embryo straight, usually very small:

414 KEY TO FAMILIES OF DICOTYLEDONS

- Stamens definite (sometimes reduced to one) ; calyx often petaloid, usually long-tubular ; flowers often in heads *Thymelaeaceae*
- Herbs sometimes a little woody at the base ; embryo more or less curved :
 - Calyx often hyaline all over ; stamens often slightly perigynous and connate at the base *Amarantaceae*
 - Calyx herbaceous ; stamens hypogynous or slightly perigynous, mostly free *Chenopodiaceae*
 - Flowers arranged in a cyathium margined with glands, monoecious *Euphorbiaceae*
- Leaves alternate or radical or reduced to scales ; sometimes tubiform or pitcher-like (from p. 412):
- Parasitic plants with the leaves reduced to scales ; anthers opening by valves *Lauraceae*
- Not parasitic ; leaves normally developed :
 - Leaves stipulate (to p. 415):
 - Stamens monadelphous, usually numerous ; calyx mostly valvate :
 - Anthers 2-locular ; flowers unisexual *Sterculiaceae*
 - Anthers 1-locular ; flowers hermaphrodite *Malvaceae*
 - Anthers 2-locular ; flowers unisexual *Euphorbiaceae*
 - Stamens free or shortly connate at the base :
 - Stamens the same number as the sepals and alternate with them :
 - Trees, shrubs or climbers *Rhamnaceae*
 - Stamens the same number as the sepals and opposite to them or more numerous or fewer :
 - Leaves compound :
 - Flowers unisexual :
 - Ovary 1-locular, of 1 carpel *Moraceae*
 - Ovary 2- or more-locular *Euphorbiaceae*
 - Flowers hermaphrodite :
 - Seeds without endosperm ; style basal or ventral on the 1-carpelled ovary *Rosaceae*
 - Seeds usually with endosperm ; style or styles more or less terminal ; ovary of more than 1 carpel *Saxifragaceae*
 - Leaves simple :
 - Ovary 2- or more-locular :
 - Flowers unisexual :
 - Ovary quite superior ; anthers opening by slits :
 - Male flowers not in catkins *Euphorbiaceae*
 - Male flowers in catkins *Betulaceae*
 - Ovary semisuperior ; anthers often opening by valves *Hamamelidaceae*
 - Flowers hermaphrodite :
 - Trees or shrubs ; ovary 2-locular ; carpels often free at the top ; anther-loculi often opening by valves ; stipules often paired *Hamamelidaceae*

KEY TO FAMILIES OF DICOTYLEDONS 415

Herbs:

Stamens perigynous ; ovary 1-3-locular

Saxifragaceae

Ovary 1-locular, mostly of 1 carpel:

Stipules ochreate, i.e. sheathing and more or less
membranous around the stem *Polygonaceae*

Stipules not ochreate:

Ovary of 1 carpel ; stamens inflexed in bud ;
flowers mostly unisexual:

Herbs

Urticaceae

Trees or shrubs

Moraceae

Ovary of 1 carpel ; stamens erect in bud ; flowers
hermaphrodite *Rosaceae*

Ovary usually of more than 1 carpel ; stamens
erect in bud ; flowers always unisexual

Euphorbiaceae

Leaves exstipulate:

Stamens the same number as and alternating with the calyx-
lobes ; leaves compound, mostly pinnate *Burseraceae*

Stamens the same number as the calyx-lobes and opposite to
them or more numerous or fewer:

Leaves compound:

Herbs ; ovary composed of 1 carpel ; leaves ternately com-
pound ; flowers paniculate or racemose, usually very
small *Ranunculaceae*

Shrubs or trees:

Stamens the same number as and opposite to the calyx-
(perianth) segments ; leaves often many times
divided ; flowers often in heads or dense spikes or
racemes ; calyx mostly petaloid *Proteaceae*

Stamens usually more numerous than the calyx-lobes ;
calyx rarely petaloid:

Flowers unisexual ; leaves digitate *Euphorbiaceae*

Flowers mostly polygamous ; leaves pinnate ; bark
bitter, not resinous *Simarubaceae*

Flowers mostly polygamous dioecious ; leaves
pinnate ; bark not bitter ; wood not resinous

Sapindaceae

Flowers various ; leaves pinnate or trifoliolate ; wood
resinous *Anacardiaceae*

Leaves simple:

Leaves modified into pitchers or tubes *Nepenthaceae*

Leaves not modified as above:

Stamens circinate involute in bud ; calyx-tube often
rather long ; ovary 1-locular ; ovule 1, basal

Nyctaginaceae

Stamens sometimes inflexed but not circinate in bud:

Stamens more or less connate into a central
column (to p. 416):

Herbs or weak climbers ; calyx (perianth) often long-
tubular and oblique ; ovules numerous ; seeds
with smooth endosperm ; flowers hermaphrodite

Aristolochiaceae

416 KEY TO FAMILIES OF DICOTYLEDONS

Habit various ; flowers unisexual ; calyx not oblique ;
 disk or disk-glands often present ; ovules
 pendulous ; endosperm smooth *Euphorbiaceae*
 Trees or shrubs ; calyx mostly small, not oblique ;
 ovule erect ; seeds with ruminant endosperm

Myristicaceae

Stamens free or the filaments shortly connate only at
 the base:

Stamens distinctly perigynous or flowers unisexual ;
 sepals connate into a tube below:

Herbs ; anthers opening by longitudinal slits:

Calyx long and tubular, many-ribbed ; stamens
 about 11, unequal ; ovules 2 or more

Lythraceae

Calyx-tube short or almost absent

Crassulaceae

Trees or shrubs ; anthers opening by longitudinal
 slits:

Calyx-lobes imbricate *Thymelacaceae*

Calyx-lobes valvate:

Stamens the same number as and opposite
 the calyx-lobes *Proteaceae*

Stamens more than the primary lobes of the
 calyx *Lythraceae*

Trees or shrubs ; leaves large, very rarely
 reduced ; stamens usually double the
 number of the calyx-lobes, in 2 or 4 rows ;
 anthers opening by valves *Lauraceae*

Stamens hypogynous or slightly perigynous if ac-
 companied by a disk, or flowers unisexual:

Flowers in a cyathium margined by bracts

Euphorbiaceae

Flowers not in a cyathium:

Trees or shrubs:

Leaves glandular ; flowers in catkin-like
 spikes or racemes ; berry often warted

Myricaceae

Leaves not glandular ; flowers not in catkin-
 like inflorescences:

Flowers unisexual ; ovule solitary, pendu-
 lous ; seeds with straight embryo

Euphorbiaceae

Flowers hermaphrodite ; ovule solitary,
 pendulous ; embryo straight

Oleaceae

Flowers unisexual or polygamous ; ovules
 2 in each loculus, collateral or the
 lower ascending ; seeds without endo-
 sperm ; embryo spirally twisted

Sapindaceae

Herbs:

Perianth herbaceous

Chenopodiaceae

Perianth more or less scarious *Amarantaceae*

KEY TO FAMILIES OF DICOTYLEDONS 417

GROUP 13

One carpel or two or more than one united carpels with axile, basal or apical placentas ; ovary inferior ; petals present

Leaves opposite or verticillate, never all radical, rarely reduced to scales (to p. 418):

Leaves compound, much divided or unifoliate ; flowers mostly umbellate or capitate, rarely racemose ; calyx small, entire or toothed ; petals usually 5, valvate or slightly imbricate ; disk on top of the ovary, often confluent with the style or styles ; ovule solitary in each loculus, pendulous ; seeds with copious endosperm and small embryo:

Trees or shrubs ; petals usually valvate ; ovary 1 - many-locular ; fruit usually a berry or drupe *Araliaceae*

Herbs ; petals imbricate, rarely valvate ; ovary 2-locular ; styles 2 ; fruit of dry indehiscent mericarps *Umbelliferae*

Leaves simple:

Leaves stipulate:

Stamens the same number as and opposite the petals

Rhamnaceae

Stamens alternate with the petals or more numerous:

Ovary composed of 2 carpels, more or less free at the apex ; flowers mostly capitate ; ovules pendulous ; trees or shrubs ; anthers often opening by valves

Hamamelidaceae

Ovary composed of 2-6 carpels, 2-6-locular or 1-locular by suppression of the septa ; flowers rarely congested ; ovules pendulous ; mostly maritime trees or shrubs

Rhizophoraceae

Ovary various ; flowers rarely in heads ; ovules ascending or attached to the central axis ; trees, shrubs or herbs

Rosaceae

Leaves exstipulate:

Trees, shrubs or climbers (to p. 418):

Stamens numerous:

Ovary loculi not superposed:

Leaves gland-dotted ; style simple with a small capitate stigma or very rarely 3-4-lobed

Myrtaceae

Leaves with pellucid lines or with stellate hairs ; style 5-10-lobed or styles 3-5 and more or less free ; ovary 2-10-locular

Hydrangeaceae

Leaves not gland-dotted, with longitudinally parallel nerves ; stamens jointed, the connective often produced at the base ; anthers opening by a terminal pore

Melastomaceae

Ovary loculi superposed ; leaves not gland-dotted ; style simple

Punicaceae

Stamens as many to twice as many as the petals:

Stamens the same number as and opposite to the petals ; mostly parasitic shrubs or trees ; calyx usually much reduced

Loranthaceae

418 KEY TO FAMILIES OF DICOTYLEDONS

- Stamens the same number as and alternate with the petals or more numerous:
 - Anthers opening by a terminal pore ; filaments often jointed ; leaves often with 3-9 longitudinally parallel nerves *Melastomaceae*
 - Anthers opening by longitudinal slits ; calyx mostly valvate:
 - Ovule solitary ; fruits mostly drupaceous ; endosperm copious ; petals without alternate scales *Cornaceae*
 - Ovules numerous ; fruit a capsule or berry ; flowers conspicuous ; no scales *Hydrangeaceae*
 - Ovules 2 or more ; fruits mostly winged ; endosperm absent ; flowers in heads, spikes, racemes or panicles *Combretaceae*
- Herbs ; sometimes slightly woody, but then often with fleshy leaves:
 - Anthers opening by a terminal pore ; leaves mostly with longitudinally parallel nerves ; connective of anthers usually produced at the base and jointed to the filament *Melastomaceae*
 - Anthers opening by longitudinal slits:
 - Flowers in umbels or heads ; ovary 2-locular, carpels separating in fruit and suspended by the divided thread-like central axis (carpophore) *Umbelliferae*
 - Flowers in heads surrounded by bracts ; ovary 2-3-locular ; carpels not as above *Cornaceae*
 - Flowers not in umbels or heads ; carpels not separating in fruit *Saxifragaceae*
- Leaves alternate or all radical:
 - Flowers unisexual (to p. 419):
 - Flowers not in heads or umbels, sometimes paniculate or racemose:
 - Leaves stipulate ; stipules paired ; no tendrils ; stamens mostly numerous, straight ; flowers often somewhat zygomorphic *Begoniaceae*
 - Leaves without stipules ; tendrils often present ; stamens definite or rarely many ; anthers often conduplicate or twisted, mostly 3 ; flowers actinomorphic, conspicuous *Cucurbitaceae*
 - Leaves without stipules or if present then adnate to the petiole, sometimes anisophyllous and then the smaller leaf appearing like a stipule ; no tendrils ; anthers straight *Rhizophoraceae*
 - Flowers arranged in heads, umbels or corymbs:
 - Fruit of dry indehiscent mericarps ; ovary 2-locular, styles 2 ; herbs with usually much dissected leaves *Umbelliferae*
 - Characters not as above:
 - Anthers opening by a single lateral valve ; petals linear-spathulate ; ovary 2-locular ; ovules solitary ; leaves stipulate *Hamamelidaceae*
 - Anthers opening by slits ; petals usually not linear-spathulate:
 - Leaves usually stipulate ; flowers usually umbellate *Araliaceae*
 - Leaves without stipules ; flowers capitate or corymbose:
 - Petals imbricate *Nyssaceae*
 - Petals valvate *Cornaceae*

KEY TO FAMILIES OF DICOTYLEDONS 419

Flowers hermaphrodite:

Stamens numerous:

Aquatic herbs with floating leaves ; flowers usually large and showy ; ovules numerous *Nymphaeaceae*

Not aquatic:

Leaves gland-dotted ; stamens mostly very numerous:

Fruits not winged

Myrtaceae

Fruits broadly winged

Lecythidaceae

Leaves not gland-dotted:

Style more or less divided or styles separate ; rarely maritime ; leaves often compound ; leaves stipulate:

Stipules not intrapetiolar

Rosaceae

Stipules intrapetiolar and connate ; leaves digitate

Araliaceae

Style simple ; usually maritime ; leaves simple

Rhizophoraceae

Stamens definite in relation to the sepals and petals, the same number as or about twice as many, rarely fewer:

Stamens the same number as and opposite the petals:

Leaves stipulate or not ; not parasites ; flowers often crowded into heads ; ovary 3-locular *Rhamnaceae*

Leaves exstipulate ; often parasitic ; ovary 1-locular

Loranthaceae

Stamens the same number as and alternate with the petals or more numerous or fewer:

Anthers opening by apical pores ; leaves often with very prominent longitudinally parallel nerves ; anthers often unequal, with the connective produced at the base

Melastomaceae

Anthers not opening by pores ; leaves usually not as above:

Leaves stipulate:

Herbs

Umbelliferae

Trees or shrubs:

Leaves simple ; stipules paired ; flowers often capitate ; fruit woody ; stamens up to twice as many as the petals

Hamamelidaceae

Leaves compound, rarely simple, stamens as many as the petals ; fruit a berry or drupaceous ; flowers often umbellate

Araliaceae

Leaves compound or simple ; stamens more than the petals ; fruit not woody

Rosaceae

Leaves exstipulate:

Flowers arranged in heads surrounded by a brightly coloured involucre and simulating a single flower ; petals very unequal, fewer than the stamens ; styles subulate, elongate

Hamamelidaceae

Flowers not as above and other characters not associated:

Herbs:

Flowers umbellate ; ovules solitary, pendulous:

Ovary 2-locular ; carpels separating in fruit into 2 indehiscent mericarps

Umbelliferae

Ovary 3-4-locular ; carpels not separating in fruit

Araliaceae

420 KEY TO FAMILIES OF DICOTYLEDONS

Flowers not umbellate:

Ovules more than 1 in each loculus or in a 1-locular ovary:

Mostly scapigerous herbs ; ovary 1-3-locular
Saxifragaceae

Leafy-stemmed herbs ; ovary mostly 4-locular
Onagraceae

Ovules solitary in each loculus of the ovary
Rosaceae

Shrubs, trees or climbers:

Flowers umbellate ; fruit a berry or drupe
Araliaceae

Flowers not umbellate:

Petals loriform, valvate
Alangiaceae

Petals not loriform:

Petals imbricate ; stamens various
Combretaceae

Petals valvate, or if slightly imbricate then
stamens usually 5:

Fruit a capsule or berry ; shrubs or trees
Escalloniaceae

Fruit a drupe ; shrubs or trees
Cornaceae

Petals convolute or inflexed ; leaves anisophyllous
Rhizophoraceae

GROUP 14

One carpel or two or more united carpels with axile, basal, or apical placentation ; ovary inferior ; petals present, more or less united

Leaves opposite (to p. 421):

Leaves stipulate, stipules mostly inter- or intra-petiolar ; anthers free from each other:

Leaves simple, entire ; corolla actinomorphic
Rubiaceae

Leaves pinnate ; flowers actinomorphic or zygomorphic
Caprifoliaceae

Leaves exstipulate:

Leaves usually with longitudinally parallel main nerves ; stamens often double the number of the corolla-lobes, mostly jointed, the connective produced at the base into an appendage

Melastomaceae

Leaves and stamens not as above:

Anthers free from each other ; ovules mostly pendulous:

Leaves not gland-dotted ; mostly herbaceous plants, rarely shrubs ; stamens definite:

Stamens double the number of the corolla-lobes ; ovary 6-locular ; a large tree
Lythraceae

Stamens the same number as the corolla-lobes:

Stamens alternate with the usually imbricate corolla-lobes ; not parasitic
Caprifoliaceae

Stamens opposite the valvate corolla-lobes ; often parasitic
Loranthaceae

KEY TO FAMILIES OF DICOTYLEDONS 421

- Leaves gland-dotted ; stamens mostly numerous ; trees or shrubs *Myrtaceae*
- Anthers mostly connivent or in pairs around the style *Compositae*
- Leaves alternate or radical :
 - Anthers free from one another or very slightly connate only at the base :
 - Stamens the same number as and opposite the corolla-lobes :
 - Herbaceous, leaves not gland-dotted *Primulaceae*
 - Trees and shrubs :
 - Not parasitic ; leaves gland-dotted *Myrsinaceae*
 - Often parasitic ; leaves not gland-dotted *Loranthaceae*
 - Stamens alternate with the corolla-lobes or more numerous or fewer :
 - Leaves gland-dotted ; stamens mostly numerous *Myrtaceae*
 - Leaves not gland-dotted :
 - Stamens free from the corolla :
 - Petals valvate ; stipules present, often adnate to the petiole *Araliaceae*
 - Petals valvate ; stipules absent *Lecythidaceae*
 - Petals imbricate, rarely valvate :
 - Stipules absent ; leaves simple *Vacciniaceae*
 - Stipules present, adnate to the petiole ; leaves compound *Araliaceae*
 - Petals contorted ; small stipules present ; branches hooked *Ancistrocladaceae*
 - Stamens epipetalous :
 - Ovary 3-5-locular ; ovule 1, or when more axile ; flowers not in a capitulum :
 - Stamens numerous ; filaments free or partially connate *Symplocaceae*
 - Stamens mostly 5 or 10 ; filaments not united at the base *Styracaceae*
 - Ovary 1-2-locular ; ovule solitary, pendulous ; flowers in cymes *Alangiaceae*
 - Anthers more or less united into a ring around the style *Compositae*

GROUP 15

One carpel or two or more united carpels with axile, basal or apical placentation ; ovary inferior ; petals absent

Parasitic herbs destitute of chlorophyll, the leaves reduced to scales ; ovules nude or with a single integument *Lauraceae*

Not parasitic, or if so then more or less woody and often with normally developed leaves (at least with chlorophyll) :

Leaves stipulate :

Flowers unisexual ; stipules often paired :

Stamens and ovules numerous ; fruit often winged ; outer pair of calyx-lobes valvate ; herbs, often with obliquely shaped leaves *Begoniaceae*

422 KEY TO FAMILIES OF DICOTYLEDONS

- Stamens and ovules few, the latter solitary or paired:
 - Male flowers with a calyx:
 - Ovule 1 in the ovary *Moraceae*
 - Ovules 2 in each loculus *Fagaceae*
 - Male flowers without a calyx *Corylaceae*
- Flowers hermaphrodite, often solitary or racemose:
 - Stamens the same number as and alternate with the sepals *Rhamnaceae*
 - Stamens the same number as and opposite or more numerous than the sepals:
 - Leaves alternate; ovules 2, pendulous; flowers racemose *Rosaceae*
 - Leaves alternate or opposite; ovules 2 - many; flowers solitary or in short racemes *Rhizophoraceae*
 - Flowers rarely unisexual, spicate or capitate, often precocious; leaves alternate; ovule 1, pendulous *Hamamelidaceae*
- Leaves exstipulate; but sometimes when opposite connate and sheathing at the base:
 - Flowers usually in catkins or slender spikes, or rarely the males in panicles, unisexual:
 - Leaves pinnate; ovule 1, erect *Juglandaceae*
 - Leaves simple, alternate; ovules 1-2, descending *Cupuliferae*
 - Flowers not in catkins, mostly hermaphrodite:
 - Calyx calyptrate; leaves opposite, gland-dotted *Myrtaceae*
 - Calyx not calyptrate; leaves not gland-dotted:
 - Flowers in simple or compound umbels; herbs; leaves sheathing at the base; ovary 2-locular, separating in fruit into 2 mericarps with resinous canals *Umbelliferae*
 - Flowers not or rarely in umbels; fruit not separating into mericarps:
 - Ovules numerous on axile placentas:
 - Calyx actinomorphic:
 - Ovary many-locular *Sonneratiaceae*
 - Ovary 1-4-locular *Onagraceae*
 - Calyx zygomorphic *Aristolochiaceae*
 - Ovules solitary or few, inserted at the top or base of the ovary:
 - Ovules pendulous from the apex of the ovary or at the apex of a basal placenta, usually more than 1:
 - Anthers opening by valves:
 - Leaves simple; calyx-lobes imbricate *Lauraceae*
 - Leaves simple or compound; calyx-lobes valvate *Hernandiaceae*
 - Anthers opening by longitudinal slits:
 - Stamens erect in bud, often double the number of the sepals *Nyssaceae*
 - Stamens inflexed in bud, often double the number of the sepals *Combretaceae*
 - Stamens erect in bud, the same number as and opposite the sepals *Santalaceae*
 - Ovule 1, erect:
 - Mostly maritime trees and shrubs with often lepidote leaves; flowers not capitate *Elaeagnaceae*

KEY TO FAMILIES OF DICOTYLEDONS 423

Not maritime ; leaves not lepidote ; flowers capitate or
densely crowded ; ovule well developed at flowering
time *Rhamnaceae*

Mostly parasitic ; flowers not capitate ; ovule scarcely
developed at time of flowering *Loranthaceae*

INDEX

Generic and specific names not accepted as valid by the author are italicized

- Abies 9, 10, 12, 16, 371; *delavayi* 16, 17; *densa* 16, 17; *pindrow* 16, 17; *spectabilis* 16, 17; *webbiana* 17
 Abroma augusta 162
 Abrus 85, 87; *precatorius* 87
 Abutilon 165
 Acacia 75, 76, 80, 205, 294, 361; *arabica* 80, 82, 111; *caesia* 84; *campbellii* 81, 82; *canescens* 84; *catechu* 81, 82, 83; *chundra* 81, 83; *columnaris* 84; *concinna* 84; *dealbata* 80; *decurrens* 80; *diadenia* 84; *eburnea* 81, 82; *farnesiana* 80, 82; *gageana* 84; *latronum* 81, 82; *leucophloea* 81, 82; *melanoxylon* 80; *modesta* 81, 83, 235; *oxyphylla* 84; *pennata* 84; *planifrons* 81, 82; *roxburghii* 81, 82; *rugata* 84; *senegal* 81, 83; *sundra* 83; *tomentosa* 81, 82; *torta* 84; *wightii* 81, 82
 Acalypha 170, 182
 Acanthaceae 329, 330, 331, 367
 Acanthoideae 331
 Acanthus ilicifolius 332
 Acer 17, 262, 370; *pentaponticum* 278; *pseudoplatanus* 262; *saccharinum* 262
 Aceraceae (PLATE XXVI), 258, 261, 370
 Achras 231, 233; *sapota* 233; *zapota* 233
 Aconitum 311, 312
 Acrocarpus 69, 72, 362; *iraxinifolius* 72
 Acronychia *laurifolia* 246; *pedunculata* 246
 Actaea 311
 Actephila 168, 174; *excelsa* 174; *puberula* 174
 Actinodaphne 49, 56
 Adam's Needle 340
 Adansonia digitata 164, 361
 Adenanthera 75, 77; *pavonina* 77
 Adenochlaena *indica* 180
 Adhatoda vasica 332
 Adiantum 8
 Adina 290, 291; *cordifolia* 291
 Aegialitis rotundifolia 324
 Aegiceras 215; *corniculatum* 230; *majus* 230
 Aegle 245; *marmelos* 245
 Aerva 319; *scandens* 319; *tomentosa* 319
 Aesculus 17, 259, 260, 371; *indica* 260; *punuana* 260
 Afzelia 69, 74; *bijuga* 74; *palembanica* 74
 Aganosma 281, 287; *caryophyllata* 287; *cymosa* 287; *dichotoma* 287; *marginata* 287
 Agapetes 199
 Agar wood 147
 Agavaceae 339
 Agavales 339
 Agave 351
 Ageratum 327
 Aglaia 252, 254, 255; *roxburghiana* 255
 Agrimonia 62
 Agrostistachys 169, 179; *gaudichaudii* 179; *indica* 179; *meeboldii* 179
 Ailanthus 247, 368, 370; *excelsa* 248; *glandulosa* 248; *grandis* 248; *malabarica* 248; *triphysa* 248
 Alangiaceae (PLATE V), 99, 101
 Alangium 101, 102; *barbatum* 102; *begoniifolium* 102; *chinense* 101; 102; *ebenaceum* 102; *kingianum* 102; *lamarckii* 101; *nobile* 102; *salviifolium* 101, 102
 Albizzia 76, 78, 90, 361, 366, 368; *chinensis* 78, 79; *gamblei* 79; *julibrissin* 78; *kalkora* 78; *lebbek* 78, 79; *lebbekioides* 78; *leucophloea* 365; *lucida* 78, 79; *myriophylla* 78, 79; *odoratissima* 78; *procera* 78; *stipulata* 79, 363
 Alchemilla 62
 Alchornea 170, 180
 Alcimandra 42, 43; *cathcartii* 43
 Alder 113
 Aleurites 169, 178, 179; *fordii* 178; *moluccana* 178; *montana* 178
 Alexandrian Laurel 202
 Algae 1, 2
 Allophyllus 259, 260
 Almond 65
 Alnus 113; *nepalensis* 113, 114, 118; *nitida* 113
 Aloe 342
 Aloe wood 147
 Alpina 337; *allughas* 337
 Alseodaphne 49, 53; *dumicola* 54; *keenani* 54; *merguensis* 53, 54; *owdenii* 54, 365; *petiolaris* 53, 54; *semecarpifolia* 54; *semecarpifolia* var. *angustifolia* 54; *semecarpifolia* var. *parvifolia* 54
 Alsodeia *bengulensis* 153
 Alsophila 1
 Alstonia 281, 283; *neriifolia* 283; *scholaris* 283; *venenata* 283
 Altingia 106, 107, 371; *excelsa* 107

- Amarantaceae 318, 319, 371, 372
 Amaryllidaceae 335
 Amentiferae 33
 Amherstia 69, 73; nobilis 73
 Amoora 252, 255, 364; canarana 255;
 cucullata 255; lawii 255; rohituka
 255; wallichii 255
 Ampelidaceae 240, 244
 Anacardiaceae (PLATE XXVII), 31, 50,
 239, 258, 262, 263, 264, 362, 364,
 365, 367, 370, 372
 Anacardium 264, 265; occidentale 265
 Anacolata 236, 237; densiflora 237
 Anagallis arvensis 323
 Anatto Dye 142
 Ancistrocladaceae 187, 189, 370
 Ancistrocladus 189, 370; heyneanus
 189
 Andaman Bullet wood 235; Redwood
 90
 Andromeda ovalifolia 198
 Androsace 323
 Anemone 311
 Angiospermae 27
 Angiosperms 1, 6, 27, 31, 33, 34, 36, 38
 Anisoptera 190, 193; oblonga 194
 Annona 44, 369; muricata 44; reti-
 culata 44, 369; squamosa 44, 369
 Annonaceae (PLATE I), 44, 59, 361, 362,
 370, 371, 372
 Annonales 33, 44
 Anodendron 282, 287; *manubriatum*
 287; paniculatum 287
 Anogeissus 210, 214, 370; acuminata
 214, 215; latifolia 179, 214, 250;
 pendula 214; sericea 214
 Anthocephalus 290; cadamba 290;
 indica 290, 361
 Antiaris 133, 138; toxicaria 138, 364
 Antidesma 169, 175; bunius 175;
 diandrum 176; ghaosembilla 176
 Apetalae 30
 Aphanamixis 255; polystachya 255
 Apium graveolens 326
 Apocynaceae 279, 280, 287, 288, 364,
 369, 370, 372
 Apocynales 279
 Apodytes 228; beddomei 228
 Apollonias 48, 50; arnottii 50
 Aporosa 169, 177, 363
 Apple 67
 Apricot 64
 Aquifoliaceae (PLATE XVI), 224
 Aquilaria 147; agallocha 147; khasiana
 147
 Araliaceae (PLATE VI), 99, 102, 103,
 372
 Araliales 98
 Arceuthobium 22, 237, 366; minutis-
 simum 237; oxycedri 237
 Archichlamydeae 33
 Ardisia 230
 Areca 346, 350; catechu 344, 350
 Arenga 346, 350; saccharifera 350
 Argemone mexicana 364
 Aristolochiaceae 314
 Aristolochiales 314
 Arjun 212
 Arnotto Dye 142
 Arrowroot 337
 Artabotrys 44
 Artocarpus 132, 135, 364, 367; chap-
 lasha 135, 136; gomeziana 135, 136;
 hirsuta 135, 136; integra 135, 136;
 integrifolia 136; lakoocha 135, 136
 Arundinaria 355, 356; griffithiana 354
 Asclepiadaceae 25, 279, 287, 288,
 364, 366, 370, 372
 Asoka tree 74
 Asparagus 338; adscendens 338;
 curillus 338; gracilis 338; racemo-
 sus 338
 Aspidopterys 166, 370
 Asterales 33, 326
 Atropa 328
 Aucuba 99, 100; himalaica 100
 Australian Blackwood 81
 Averrhoa 332; bilimbi 332; carambola
 332
 Avicennia 300, 307, 362; alba 307,
 308; marina 307, 308; nitida 308;
 officialis 221, 307, 308; *lomentosa*
 308
 Axle wood 215
 Azadirachta 252, 254; indica 254
 Azalea 209
 Azima 228, 229; sarmentosa 229;
 tetracantha 229
 Babul 82
 Baccaurea 169, 177, 372; courtallensis
 177; sapida 177, 363
 Bacteria 1
 Bael tree 245
 Baib grass 353
 Balanites 246, 247
 Balanostreblus 133, 139; ilicifolia 139
 Baliospermum 170, 185; axillare 185;
 montanum 185
 Balsamodendron 250; *berryi* 250
 Bambusa arundinacea 356
 Banana 336
 Banyan 135, 362
 Balsa wood 163
 Baobab 164
 Barbados Gooseberry 157
 Barricari 77
 Barringtonia 206; acutangula 297;
 asiatica 206, 207; augusta 207;
 conoidea 206; macrostachya 206;
 pendula 206; pterocarpa 207;
 racemosa 206; 295; *spaciosa* 207
 Bassia 232; *bourdillonii* 233; *buty-*
 racea 232; *latifolia* 233; *longifolia*
 233; *malabarica* 233
 Bauhinia 28, 69, 74, 367, 369;
 anguina 70, 71; *malabarica* 70, 367;
 purpurea 70; racemosa 70; retusa
 70; *vahlilii* 70, 71; *variegata* 70
 Beaumontia 281, 286; grandiflora 286;
 jerdoniana 286
 Beilschmiedia 48, 50; assamica 51;
 bourdillonii 51; brandisii 51; clarkei
 51; globularia 51; macrophylla 51;

- roxburghiana 51; sikkimensis 51;
 wightii 51
 Belgaum Walnut 178
 Ben Oil 151
 Bennettitaceae 33
 Bennettitales 5, 6, 35, 36, 37
 Bennattites 36, 37
 Bentinekia 346, 350; cordapanna 350;
 nicobarica 350
 Ber tree 241
 Berberidaceae 312
 Berberidales 312
 Berberis 313
 Berchemia 240, 241; lineata 241
 Betel-Nut 344, 350
 Betula 113, 114, 363, 371; alnoides
 114; *bhojpattra* 114; cylindros-
 tachys 114; utilis 114
 Betulaceae 33, 113, 371
 Bhang 141
 Bignoniaceae 203, 204, 208, 370, 371
 Bignoniales 293
 Bilberry 199
 Birch 114
 Bird Cherry 65
 Bischofia 167, 172, 173; javanica 172,
 363, 364
 Bishop wood 172
 Bixa orellana 142, 364
 Bixaceae 142, 143, 364
 Bixales 142
 Blachia 170, 183
 Black Mangrove 230
 Blinding tree 185
 Blue Pine 13
 Boehmeria 141; nivea 141
 Boenninghausenia 245
 Bois fidèle 309
 Bombacaceae (PLATE XIV), 157, 158,
 162, 163, 362, 369, 373
Bombax malabaricum 163
 Bombay Blackwood 89
 Boraginaceae 321, 333
 Boraginales 333
 Borassus 346, 347; flabellifer 345, 347
 Bosia amherstiana 319
 Boswellia 249; serrata 249
 Bouea burmanica 268
 Bougainvillea 148
 Bowstring Hemp 340
 Brandisia 330; discolor 330
 'Braunkole' 20
Brexia madagascariensis 97
 Bridelia 168, 173; cinerascens 173;
 retusa 173; retusa var. glauca 173;
 retusa var. roxburghiana 173; retusa
 var. squamosa 173; roxburghiana
 173; squamosa 173; stipularis 173
 Broom 95
 Broussonetia 132, 137, 367; papyri-
 fera 137
 Brucea 247, 248; amarissima 249;
sumatrana 249
 Bruguiera 217, 218, 219, 302; *caryo-*
phyllodes 219; conjugata 218, 219;
 cylindrica 218, 219; *eriopetala* 218,
 219; *gymnorrhiza* 218, 219; hainesii
 219; parviflora 218, 219; sexangula
 218, 219, 362
 Bryophyta 1, 2
 Buchananiana 264, 266; lanzan 266, 363,
 365; latifolia 215, 266
 Bucklandia 106; populnea 106, 363
 Buddleja 269; asiatica 270; candida
 270; colvillei 269, 270; crispa 270;
 griffithii 269, 270; hookeri 269, 270;
 longifolia 269, 270; macrostachya
 269, 270; neemda 270; paniculata
 269, 270
 Bullock's Heart 44
 Burma Padauk 90
 Burmese Lacquer tree 264
 Burmese Storax 107
Bursera 365; serrata 250
 Burseraceae (PLATE XXIII), 245, 249,
 362, 365
 Butea 86, 92, 93, 364, 368; frondosa
 92; minor 92, 93; monosperma 92,
 93, 364; parviflora 92, 93; superba
 92, 93
 Buxaceae 105, 107
 Buxus 108; papillosa 108; wallichiana
 108
 Cabbage tree 347
 Cactaceae 156, 167
 Cactales 156
 Caesalpinia 28, 69, 71, 72
 Caesalpiniaceae 68, 69, 362, 373
 Caesia 84
 Cajuput Oil tree 205
 Calabash tree 298
 Calamus 342, 347, 351, 363
Calliandra 76, 79, 363; *cynometroides*
 79
 Callicarpa 300, 301; arborea 301;
 lanata 301; macrophylla 301;
 tomentosa 301; vestita 301
 Calligonum polygonoides 25, 318
 Callistemon 204, 205; rigida 205;
 viminalis 205
 Callitris 21, 23; rhomboidea 24
 Calophyllum 201, 202, 211, 231, 361,
 363, 367; elatum 202; inophyllum
 202, 211; tomentosum 202
 Calycopteris 210, 215; floribunda 215
 Calyciflorae 32
 Camellia 188; sinensis 187
 Camel's Foot Climber 71
 Campanales 326
 Canadian Oil of Wintergreen 197
 Canarium 249, 250, 362, 365; benga-
 lense 251; coccineo-bracteatum 251;
 euphyllum 251; mannii 251; resini-
 ferum 251, 363; sikkimense 251;
 strictum 251
 Candle Nut 178
 Candle tree 298
 Cannabinaceae (PLATE X), 129, 141
 Cannabis 141; sativa 141
 Cannonball tree 208
 Canthium 292; dicoccum 292; didy-
 mum 292
 Capparidaceae 150, 369

- Capparidales 150
 Capparis 150; *aphylla* 150, 229
 Caprifoliaceae 288, 290, 293, 373
 Caragana 85, 86; *brevispina* 87;
decorticans 87; *gerardiana* 87;
pygmaea 86; *sukiensis* 87
 Carallia 216, 217, 220, 362; *brachiata*
 220; *integerrima* 220; *lucida* 220
 Carapa 256, 362, 363; *molluccensis*
 256; *obovata* 256
 Caraway-seed 326
 Cardamoms 337
 Cardiospermum 259; *halicacabum* 259
 Careya 206, 207; *arbores* 207;
herbacea 207
 Caricaceae 155, 156, 364
 Carica papaya 156, 239, 364
 Carissa 280, 282; *carandas* 282; *opaca*
 282
 Carpinus 115, 126; *laginea* 115;
viminea 115
 Carrot 326
 Carum carvi 326
 Caryophyllales 33
 Caryota 346, 348; *mitis* 348; *obtusa*
 348; *urens* 345, 348
 Casearia 144, 146; *glomerata* 146;
rubescens 146
 Cashew-Nut 265
 Cassava plant 184
 Cassia 69, 72, 369; *fistula* 72; *glaucia*
 72; *javanica* 72; *marginata* 72, 73;
nodosa 72; *renigera* 72; *siamea* 72
 Cassiope 197; *fastigiata* 197
 Cassytha 48, 49, 57, 366; *filiformis* 57
 Castanea 116, 125, 371; *sativa* 125,
 159
 Castanopsis 116, 123, 371; *argentea*
 123, 124; *argyrophylla* 123, 124;
armata 123, 124; *birmanica* 123,
 125; *castanicaarpa* 123, 124; *clarkei*
 123, 124; *diversifolia* 123, 124;
hystrix 123, 124; *indica* 123, 124;
rhamnifolia 123, 125; *tribuloides*
 123, 125; *wallichii* 123, 125
 Castilla 132, 137, 364; *elastica* 137
Castilleja 137
 Castor-oil plant 183
 Casuarina 127, 128; *equisetifolia* 127,
 128; *glaucia* 128; *montana* var.
validior 128; *quadrivalvis* 128;
suberosa 128
 Casuarinaceae (PLATE IX), 33, 127, 366
 Casuarinales 127
 Catalpa 293, 298; *bignonioides* 299;
kaempferi 299; *speciosa* 299
 Ceara Rubber tree 184
 Cedrela 251, 252, 253, 257, 366, 371,
 374; *febrifuga* 257; *kingii* 257, 258;
microcarpa 257, 258; *serrata* 257;
toona 257, 258
 Cedrus 9, 12, 17, 18, 19, 371; *deodara*
 18
 Ceiba 162, 362, 363, 366, 369;
pentandra 163
 Celastraceae 224, 225, 371
 Celastrales 33, 224
 Celastrus 225, 227
 Celery 326
 Celosia 319
 Celtis 129, 130, 365; *australis* 130,
 365; *caucasica* 130; *cinnamomea*
 131; *eriocarpa* 130; *tetrandra* 131;
wightii 131
 Cephaelis ipecacuanha 290
 Cephalotaxaceae 9, 11
 Cephalotaxus 9, 10, 12; *griffithii* 12;
mannii 12
 Cerbera 280, 282; *lactaria* 282; *man-*
ghas 282; *odollam* 282
 Cereus hexagonus 157
 Ceriops 217, 220, 362; *candolleana*
 220; *roxburghiana* 220; *tagal* 220
 Ceylon Rosewood 78
 Chaetocarpus 170, 186; *castanicaarpa*
 186
 Chaillotiaceae 62, 68
 Chalcididae 133
 Chamaerops 346, 347; *humilis* 340, 347
 Champa 43
 Chaplash 136
 Charas 141
 Chaulmugra oil 144
 Chenopodiaceae 318, 371
 Chenopodiales 318
 Chilauni 187
 Chilgoza Pine 13
 Chinar 107
 Chinese coffin-tree 21
 Chinese tallow tree 186
 Chir Pine 14
 Chisocheton 251, 252, 254, 255
 Chlamydoalanus 117
 Chloroxylon 252, 253, 367, 371;
swietenia 90, 253
 Chonemorpha 281, 286; *fragrans* 286;
macrophylla 286
 Chorisandra 168, 174; *pinnata* 174
 Chorisia 363; *speciosa* 164, 361
 Chrysophyllum 231; *cainito* 231; *rox-*
burghii 231
 Chukrasia 252, 253, 256, 371; *tabu-*
laris 256; *velutina* 256
 Cicca 168, 175; *acida* 175; *disticha*
 175
 Cinchona 290
 Cinchoneae 292
 Cinnamomum 49, 51, 56, 365, 367,
 368; *cacharensense* 53; *camphora* 52,
 53; *caudatum* 52, 53; *cecidodaphne*
 53; *glanduliferum* 53; *gracile* 52;
iners 52; *litseaefolium* 52; *macro-*
carpum 52; *obtusifolium* 52; *pauci-*
florum 52; *perrottetii* 52; *riparium*
 52; *sulphuratum* 52; *tamala* 52, 53;
tavoyanum 52; *travancoricum* 52;
wightii 52; *zeylanicum* 52, 53
 Cipadessa 253, 257; *baccifera* 257;
fruticosa 257
 Cissampelos 313
 Cissus elongata 244, 315; *repanda* 244
 Citharexylum subserratum 308
 Citrus 245, 366
 Civet Cat 163

- Claoxylon 170, 182; *indicum* 182; *polot* 182
 Clausena pentaphylla 246
 Cleidion 170, 180, 181; *javanicum* 180; *spiciflorum* 180
 Cleistanthus 168, 174; *collinus* 174; *myrianthus* 174; *patulus* 174
 Clematis 311
 Clerodendrum 300, 303, 304; *indicum* 303, 304, 362; *inermis* 148, 303; *infortunatum* 303; *petasites* 303; *phlomoides* 303; *serratum* 303, 304; *siphonanthus* 304; *squamatum* 303, 304; *thomsonae* 304
 Clove tree 205
 Cocculus laurifolius 314
 Cochlearia amoracia 151
 Cochlospermaceae 142, 373
 Cochlospermum 142, 369; *gossypium* 142; *religiosum* 142
 Cocoa tree 161
 Coconut 344
 Coconut Palm 350
 Cocos 346, 350; *nucifera* 350
 Codiaeum 170, 178, 183; *variegatum* 183
 Coelodepas 170, 180; *calycinum* 180
 Coffea bengalensis 284
 Colebrookea oppositifolia 334
 Colona 158, 159, 370; *floribunda* 159
 Columbia 158, 159
 Colvillea racemosa 75
 Colville's Glory 75
 Combretaceae 57, 159, 203, 209, 214, 362, 370
 Combretum 210, 215, 216, 370; *apetalum* 216; *decandrum* 216
 Commiphora 249, 250; *berryi* 250; *caudata* 250, 363; *mukul* 250; *pubescens* 250
 Compositae 326, 327, 364, 372, 373
 Condori wood 77
 Congea 300, 307, 371; *tomentosa* 307
 Coniferae 31, 361, 371
 Coniferales 5, 6, 9
 Coniferophytes 5
 Conifers 8, 31
 Connaraceae 60, 371, 373
 Conocephalus 132, 135; *suaveolens* 135
 Convolvulaceae 25, 328, 373
 Copaiba Balsam 74
 Coptis 311; *teeta* 311
 Coral tree 93
 Coral wood 77
 Corchorus capsularis 158; *olitorius* 158
 Cordaitales 5, 6, 8, 9
 Cordia 273; *dichotoma* 273, 274, 365; *domestica* 273, 274; *fragrantissima* 273, 274; *fulvosa* 274; *grandis* 273, 274; *macleodii* 273, 274; *monoica* 273, 274; *myxa* 274; *myxa* var. *domestica* 274; *obliqua* 274; *octandra* 274, 275; *rothii* 274; *sebestena* 274, 275; *subcordata* 274, 275; *vestita* 273, 274; *wallichii* 273, 274
 Cordyline 339; *terminalis* 340
 Coriander 326
 Coriandrum sativum 326
 Coriaria nepalensis 62
 Coriariaceae 61
 Coriariales 61
 Cornaceae 99, 101, 339
 Cornus 99, 100; *capitata* 100; *controversa* 100; *macrophylla* 100; *oblonga* 100
 Corylaceae 113, 114, 126
 Corylopsis 106; *himalayana* 106
 Corylus 115; *colurna* 115; *ferox* 115, 116
 Corypha 341, 346, 348; *umbraculifera* 341, 348
 Costus speciosus 337
 Cotoneaster 63, 66; *acuminata* 67; *bacillaris* 66, 67; *buxifolia* 66; *integerrima* 67; *lindleyi* 66, 67; *microphylla* 66; *nummularia* 66, 67; *rosea* 67
 Cotton tree 163
 Couroupita guianensis 208, 363
 Cowberry 199
 Cranberry 199
 Crataegus 63, 67; *crenulata* 67; *oxyacantha* 67
 Crataeva 173; *roxburghii* 369; *unilocularis* 150
 Cratoxylon 200, 371; *formosum* 200
 Crescentia cujete 298
 Crotalaria 86, 92, 369; *juncea* 92; *striata* 92
 Croton 169, 177, 186, 368; *caudatus* 178; *sparsiflorus* 178; *tiglium* 177
 Cruciferae 373
 Crypteronia 367, 371; *paniculata* 98
 Crypteraniaceae 95, 97, 320, 371
 Cryptocarya 48, 49, 369; *amygdalina* 50; *anamalayana* 49; *andamanica* 50; *andersoni* 50; *beddomei* 49; *bourdillonii* 49; *caesia* 50; *ferrarsi* 50; *ferrea* 50; *griffithiana* 50; *lawsoni* 49; *neilgherensis* 49; *stocksii* 49
 Cryptogams 1, 2, 31
 Cryptomeria 9, 19, 20, 21, 361; *japonica* 11, 20
 Cryptostegia 288
 Cucurbitales 155
 Cudrania 132, 137, 138; *fruticosa* 137, 138; *javanensis* 137, 138
 Cullenia 162, 163, 368; *excelsa* 163, 367
 Cunninghamia 21
 Cunoniales 95
 Cupania 260
 Cupressaceae 9, 21
 Cupressus 9, 11, 21, 23, 371; *cashmeriana* 23; *funbris* 23; *funbris* var. *glauca* 23; *sempervirens* 23; *torulosa* 22, 23
 Curcuma 337
 Cuscuta 328, 329, 366; *reflexa* 25, 57, 309, 329
 Custard Apple 44
 Cutch 83
 Cyatheaceae 2

- Cyathocalyx 44
 Cycadaceae 7
 Cycadales 5, 6, 7, 33, 35
 Cycadeoidea 36, 37
 Cycadofilicales 5, 6, 7, 35
 Cycadophytes 5
 Cycads 8, 31, 35, 37
 Cycas 6, 7, 8; *beddomei* 7; *circinalis* 7, 8; *pectinata* 8; *revoluta* 7; *siamensis* 7, 8
 Cyclobalanopsis 117
 Cyclostemon 169, 176; *confertiflorus* 46
 Cydonia 63, 66; *vulgaris* 66
 Cymbopogon *flexuosus* 90
 Cynometra 69, 73; *cauliflora* 73; *minosoides* 73; *polyandra* 73; *ramiflora* 73; *travancorica* 73
 Cyperaceae 28
 Cythomandra *betacea* 328
 Cytinaceae 314, 315
 Cytisus *laburnum* 95; *scoparius* 95;
- Dalbergia 86, 88, 248, 368, *lanceolaria* 88, 89; *latifolia* 88, 89; *paniculata* 88, 89; *sissoo* 83, 88, 89, 186
 Daphne 147
 Daphniphyllum 169, 177; *glaucescens* 177; *himalayense* 177; *neilgherrense* 177;
 Date 345
 Date palm 345, 349
 Datisca *cannabina* 155
 Datisceaeae 155, 362, 373
 Datura 328
 Daucus *carota* 326
 Deeringia *celosioides* 319
 Dehaasia 48, 50; *kurzii* 50
 Delima 283; *sarmentosa* 61
 Delonix 69, 71, 362, 369; *regia* 71, 75, 361
 Delphinium 312
 Dendrobenthamia *capitata* 100
 Dendrocalamus *giganteus* 356; *hamiltonii* 354, 356, 357; *strictus* 354, 356, 357
 Derris 86, 88, 368; *elliptica* 88; *ferruginea* 88; *robusta* 88, 363
 Desmodium 86, 95, 369
 Deutzia 96, 97; *corymbosa* 96, 97; *staminea* 96
 Dhaincha 92
 Dhak 92
 Dialium 69, 74, 362; *travancoricum* 74
 Diatoms 1
 Dichapetalum *gelonioides* 68
 Dichroa 96, 97; *febrifuga* 97
 Dichrostachys 75, 77; *cinerea* 77
 Dicotyledones 28, 29, 41
 Dicotyledons 30, 31, 32, 33, 34, 349
 Dictamnus 245
 Didynamia 29
 Dillenia 60, 61, 202, 361, 365; *bracteata* 61; *indica* 60, 362, 363, 369; *pentagyna* 60
 Dilleniaceae (PLATE III), 60, 283, 365, 369, 371, 373
- Dilleniales 60
 Dimorphocalyx 170, 183
 Dinochloa 357
 Dioecia 29
 Diospyros 45, 46, 47, 176, 363; *ebenum* 46; *embryopteris* 46; *kaki* 45; *kurzii* 46; *lotus* 45; *marmorata* 46; *melanoxylon* 46; *montana* 46, 365; *ocarpa* 46; *peregrina* 45, *tomentosa* 46
 Dipterocarpaceae 187, 189, 366, 370
 Dipterocarpus 14, 190, 191, 361, 366; *alatus* 192; *baudii* 193; *bourdillonii* 191; *costatus* 192; *dyeri* 192, 193; *gracilis* 192, 193; *grandiflorus* 191, 192; *griffithii* 192; *incanus* 192; *indicus* 191; *kerrii* 192, 193; *macrocarpus* 193; *obtusifolius* 193; *pilosus* 192; *tuberculatus* 192, 193, 271, 322; *turbinatus* 192, 193
 Dobinea 262, 370
 Docynia 63; *indica* 66
 Dodder 309
 Dodecadenia 49, 57
 Dodonaea 259, 260, 370; *viscosa* 260
 Doekoe 255
 Dolichandrone 294, 295, 297, 371; *arcuata* 295, 296; *atrovirens* 295; *crispa* 295, *falcata* 295, 296; *rheedii* 295; *spathacea* 295; *stipulata* 296
 Dombeya *spectabilis* 162
 Double coconut 343
 Dracaena 339, 340, 342; *angustifolia* 340; *spicata* 340
 Dracontomelum 362
 Dragon's Blood 340
 Drimycarpus 263, 264, 265, 367; *racemosus* 265
 Drimys 38, 42
 Drosera 324
 Droseraceae 324
 Drypetes 176; *confertiflorus* 176; *macrophylla* 176
 Duabanga 221, 223; *sonneratioides* 137; *grandiflora* 223, 361
 Duranta *plumieri* 309, 329
 Durian 163
 Durio *zibethinus* 163, 362
 Dwarf Palmetto palm 347
 Dysoxylum 252, 254, 255; *binectariferum* 254; *hamiltonii* 254; *malabaricum* 254; *procerrum* 254
- Eagle wood 147
 East Himalayan Fir 17
 Ebenaceae (PLATE II), 45
 Ebenales 45
 Echinocarpus 158, 159
 Echites *mannubriata* 287
 Edgeworthia 147; *chrysantha* 147; *gardneri* 147
 Ehretia 273, 275; *acuminata* 275; *aspera* 275; *buxifolia* 276; *laevis* 275; *microphylla* 275, 276; *ovalifolia* 275, 276; *pubescens* 275, 276; *wightiana* 275, 276

- Ehretiaceae (PLATE XXVIII), 268, 272, 273
 Elaeocarpaceae (PLATE XIII), 158, 369, 371
 Elaeocarpus 158, 159, 160, 362, 368;
 ganitrus 160; petiolatus 160;
 varunna 160; wallichii 160
 Elacodendron 225, 227, 361, 363; glau-
 cum 227; paniculatum 227; subro-
 tundum 227
 Eleagnaceae 240, 242, 368, 373
 Eleagnus 242; conferta 243; hortensis
 243; indica 243; kologa 243; lati-
 folia 243; umbellata 243
 Elm tree 129
 Emblica 168, 174, 175; officinalis 175
 Endlandra 48, 51; firma 51
 Endospermum chinense 186
 Eng oil 190; forests 196
 Engelhardtia 126, 362, 371; acerifolia
 126; colebrookiana 126, 127; poly-
 stachya 126; spicata 122, 126, 127;
 wallichiana 126
 English Elm 130; Hazel 106; Lilac
 278
 Engyin 196
 Enkianthus 197, 198; deflexus 198;
 himalaicus 198
 Entada 75, 77; phaseoloides 77;
 scandens 77
 Enterolobium 76, 80; saman 80, 361;
 timbouva 80, 361, 369
 Ephedra 24, 25, 26, 127; foliata 25;
 gerardiana 25, 26; intermedia 25,
 26; intermedia var. tibetica 25;
 nebrodensis 25, 26; nebrodensis var.
 procera 25; pachyclada 25; regeliana
 25; saxatilis 25; saxatilis var. sikki-
 mensis 25; sinica 25, 26
 Equisetum 1
 Ereumurus himalaicus 338
 Ericaceae 196, 197, 199, 373
 Ericales 196
 Eriobotrya 63, 66; bengalensis 66;
 japonica 66
 Eriodendron anfractuosum 163
 Erioglossum 259, 261; rubiginosum 261
 Eriolobus 63, 66; indica 66
 Ervatamia 281, 284, 370; coronaria 284
 Erythrina 86, 93, 363; arborescens 93,
 94; fusca 93, 94; indica 93, 239;
 lithosperma 93, 94; ovalifolia 94;
 resupinata 93, 94; stricta 93, 94;
 suberosa 93, 94; variegata 93
 Erythralium 236; populifolium 236;
 scandens 236
 Erythroxylaceae 166
 Erythroxylon 166; coca 166
 Escalloniaceae 95, 96, 97
 Eucalyptus 204, 205, 367; globulus 205
 Eugenia 204, 205, 216, 367; aromatica
 205; caryophyllata 205; jambolana
 205
 Eulaliopsis binata 353
 Euonymus 225, 226
 Eupatorium 327
 Euphorbia 157, 167, 171, 364; anti-
 quorum 171, 172; bojeri 172; cadu-
 cifolia 171; cattimandoo 171, 172;
 epiphylloides 171; nenifolia 171,
 172; nivulia 171, 172; pulcherrima
 172; royleana 171, 172; tirucalli
 171; tortilis 171, 172; trigona 171,
 172
 Euphorbiaceae (PLATE XV), 158, 167,
 302, 364, 366, 372
 Euphorbiales 167
 Euphoria 261; longana 261
 European Ash 277; Hazel 106; Olive
 279
 Evodia 246; meliaefolia 246
 Excoccaria 167, 170, 185; agallocha
 185; bicolor 185; cochinchensis 185;
 crenulata 185; robusta 185
 Fagaceae (PLATE VII), 33, 113, 116,
 371
 Fagales 34, 113
 Fagraea 269, 270; carnosa 270, 271;
 fragrans 270, 271; khasiana 270;
 morindaefolia 270; obovata 270, 271;
 racemosa 270; zeylanica 270, 271
 Fennel 326
 Feronia elephantum 245
 Ficus 132, 133, 134, 135, 349, 362, 363,
 364; benghalensis 135; benjamina
 135; elastica 135; infectoria 135;
 religiosa 135; retusa 135; roxburghii
 135
 Fiddle wood 309
 Filicium 259, 260; decipiens 260
 Firmiana 161, 362; colorata 161
 Flacourtia 71, 143, 145, 200, 363;
 cataphracta 145; ramontchi 145
 Flacourtiaceae (PLATE XI), 142, 143,
 158, 369
 Flemingia 86, 94; congesta 94; lineata
 94; strobilifera 94; vestita 94
 Flueggea 168, 175, 176; microcarpa
 175; obovata 175; virosa 175
 Foeniculum vulgare 326
 Frangipanni 282
 Fraxinus 276, 277, 370; excelsior 277;
 floribunda 277; griffithii 277; micran-
 tha 276, 277; velutina 277, 278;
 xanthoxyloides 277, 278
 Freycinetia 351, 352
 Fungi 1
 Galium 289
 Gamari 302
 Gamopetalae 32
 Ganja 141
 Garcinia 201, 202, 216, 220, 361, 363,
 364; cambogia 202; cowa 201; mau-
 gostana 201; morella 202
 Gardenia 290, 292
 Gardneria 268, 269, 272; angustifolia
 272; ovata 272
 Garuga 249, 250; gamblei 250; pinnata
 250
 Gaultheria 197; fragrantissima 197;
 hookeri 197; numularioides 197; tri-
 chophylla 197

- Gelonium 170, 184; bifarium 184; glomerulatum 184; lanceolatum 184; multiflorum 184
 Gelsemium 269; elegans 269
 Geraniales 332
 Geum 62
 Ginger 337
 Ginkgo 8; biloba 8
 Ginkgoales 5, 6, 8
 Girardinia heterophylla 141
 Gironuiera 129, 131, 362; cuspidata 131; lucida 131, 132; reticulata 131; subaequalis 131
 Givotia 170, 183; rottleriformis 183
 Gleditsia 69, 71, 363; macracantha 71; triacanthos 71
 Glochidion 169, 176, 372
 Gloriosa superba 338
 Glumaceae 32
 Glycosmis pentaphylla 246
 Glyptopetalum 225, 226
 Gmelina 179, 180, 300, 302; arborea 179, 238, 302, 363; arborea var. canescens 303; arborea var. glaucescens 302; asiatica 302, 303; hystrix 302; philippinensis 302
 Gnetaceae 24
 Gnetales 5, 6, 24
 Gnetum 24; gnemon 24
 Gomphandra axillaris 228; polymorpha 228
 Gomphia 188; angustifolia 189
 Gomuta fibre 351
 Goodeniaceae 326
 Gooseberry of Lahul 98
 Gordonia 371; dipterosperma 188; obtusa 188
 Gorse 95
 Gossampinus malabarica 163
 Gossypium 165, 369
 Gouania 240, 241, 242, 370
 Graminales 352
 Gramineae 28, 335, 341, 344, 352
 Green Wattle 81
 Grevillea 149, 371; robusta 149
 Grewia 102, 158, 159, 367; asiatica 159; disperma 130, 159; sapida 159; sclerophylla 159; separia 159
 Grossulariaceae 95, 96, 98
 Guaiacum officinale 83
 Guava 204
 Guazuma tomentosa 162
 Gul Mohur 71
 Gulab jaman 205
 Gum Arabic 82
 Gur 349
 Gurjan oil 190
 Guttiferae 200, 362, 364, 367, 372, 374
 Guttiferales 199
 Gymnacranthera 59
 Gymnospermae 5
 Gymnosperms 1, 5, 27, 31, 38
 Gymnosporia 225, 227
 Gynandria 29
 Gynandropsis gynandra 151
 Gynocardia 143, 145, 369; odorata 144, 362
 Gyrocarpus 57, 58, 370; americanus 58; jacquini 58
 Hakea 149; acicularis 149
 Haidu 291
 Haloxylon 371
 Hamamelidaceae 105, 106, 371
 Hamamelidales 105
 Hamamelis virginiana 106
 Hamelia 290, 292; patens 292
 Hamiltonia 289
 Hapalia machaeris 359
 Haplophragma 297; adenophyllum 296
 Hardwickia 69, 74, 368; binata 74, 76, 90; pinnata 74
 Harpullia 259, 260; arborea 260; cupanioides 369; imbricata 260
 Harrisonia 246, 247, 248; bennettii 248; brownii 248; perforata 248
 Hawthorn 67
 Hedera helix 103; nepalensis 103
 Hedychium 337
 Helicia 149; javanica 149; robusta 149
 Helicteres 160; isora 162
 Helinus 240, 241, 242; lanceolatus 242
 Helleborus 311
 Helwingia 99, 339; himalaica 99
 Hemicyclia 169, 176; clata 176
 Hemigyrosa canescens 260
 Hemp 141
 Henna tree 323
 Henslowia 238, 240
 Heptapleurum venulosum 103
 Herbae 28
 Heritiera 160, 161; fomes 161; littoralis 161, 289; macrophylla 161; papilio 161
 Hernandia 57, 58; peltata 58
 Hernandiaceae 48, 57, 370
 Heteropanax fragrans 294
 Heterophragma 294, 296, 297; adeno-phyllum 296; quadriloculare 296; roxburghii 296
 Hevea 137, 167, 172, 173, 363; brasiliensis 135, 172, 184
 Heynea 253, 257
 Hibiscus 164, 165; cannabinus 165; lampas 165; macrophyllus 165; sabbariffa 165; tiliaceus 162, 165
 Hippocratea 371
 Hippophaë 242, 243; rhamnoides 243; salicifolia 243
 Hiptage 166, 370
 Hog Plum 267
 Holarrhena 281, 283; antidysenterica 283
 Holigarna 264, 265, 365; grahamii 265, 267
 Hollock 213
 Holly 224, 332
 Holmskioldia sanguinea 309
 Holoptelea 129, 130, 370; integrifolia 130
 Homalium 144, 145; minutiflorum 145; nepalense 145; tomentosum 145; travancoricum 145; zeylanicum 145

- Homonoia 170, 182; retusa 182; riparia 182, 276
 Hop 141
 Hopea 190, 194; helferi 194; odorata 194; parviflora 194; racophloea 194; shingkeng 194; wightiana 194
 Hornbeams 115
 Horse Bean 72
 Horse Chestnut 260
 Horse-radish tree 151
 Horsfieldia 59
 Hovenia 241
 Hugonia mystax 166
 Humboldtia 69, 73
 Humulus 141
 Hunteria 280, 283; corymbosa 283
 Hyblaea pueri 359
 Hydnocarpus 143, 144, 369; alpina 144; castanea 144; dawnensis 144; kurzii 143, 144; laurifolia 144; macrocarpa 144; octandra 144; venenata 144; verrucosa 144; wightiana 144
 Hydrophytum 289; formicarium 289, 362
 Hydrangea 96; altissima 96; hortensis 96; robusta 96
 Hydrangeaceae (PLATE IV), 95, 96
 Hymenodictyon 290, 291; excelsum 292, 370; flaccidum 292; obovatum 292;
 Hymenopogon 289; parasiticus 370
 Hypericaceae 200, 367, 371, 374
 Hypericum 200
 Hyphaene 342, 361
 Hypsipyla robusta 258
 Icacinaceae 224, 227
 Ichnocarpus 282, 287; frutescens 287
 Icosandria 29
 Ilex 224; clipyrena 224; doniana 224; excelsa 224; godajam 224, 365; insignis 224
 Illicaceae 224
 Illicium 41
 Illigera 57, 58, 370; appendiculata 58; khasiana 58; villosa 58
 Imperata cylindrica 85, 353
 Imperfectae 28
 Indian Almond tree 211; Ash 277; Copal 190; Laburnum 72; Olive 278; Rosewood 89; Silver-grey Wood 214; Walnut 178
 Indiarubber tree 135
 Indigo 91
 Indigofera 86, 91
 Inga 75; cynometroides 79; dulcis 79
 Intsia 69, 74; bakeri 74, 362; bijuga 74; retusa 74
 Ironwood 77
 Isonandra 231, 232; lanceolata 232
 Itea 96, 97
 Ivy 103
 Ixora 289
 Jacaranda 294, 295; mimosifolia 295; ovalifolia 295
 Jack tree 136
 Jaman 205
 Jambosa 204, vulgaris 205
 Jarul 322
 Jasminum 269, 276, 279
 Jassus indicus 239
 Jatropha 167, 170, 183; curcas 183; gossypifolia 183; multifida 183; podagrica 183
 Juglandaceae 125, 362, 371
 Juglandales 34, 125
 Juglans 126; regia 126
 Juncaceae 28
 Juniperus 9, 21; communis 22, 23; communis var. montana 22; coxii 21, 22; drupacea 21; excelsa 22; macropoda 21, 22, 237; nana 22; pseudo-sabina 22, 23; recurva 20, 22; sibirica 22; squamata 22
 Kachnar 70
 Kadam 291
 Kaghazi 126
 Kakrasinghi 268
 Kamranga 332
 Kandelia 217, 220; rheedii 220
 Kayea 201, 202; assamica 202; floribunda 202
 Keora 222
 Kerria japonica 68
 Khasi Pine 14
 Kigelia 294, 295, 298; ethiopica 295; pinnata 295
 Kindal 213
 Kingiodendron 69, 74; pinnatum 74
 Kirganelia 168, 174, 175; reticulata 175
 Kittul fibre 348
 Kleinhowia hospita 162
 Knema 59
 Kokoona 225, 226, 371; filiformis 226; littoralis 226; zeylanica 226
 Kopsia 281, 283; fruticosa 283
 Kurrimia 225, 227; bipartita 227; indica 227; pulcherrima 227; robusta 227
 Kuteera 143
 Kydia calycina 165; jujubifolia 165
 Labiatae 31, 333, 374
 Laburnum 95
 Lagerstroemia 320, 321, 361, 369, 371; calyculata 321, 322; floribunda 321, 322; flos-reginae 322; hypoleuca 321, 322; indica 321, 322; lanceolata 321; macrocarpa 321, 322; parviflora 321, 363; speciosa 321, 322; tomentosa 321, 322
 Laktooch 136
 Lamiales 33, 333
 Lampati 223
 Lannea 264, 267, 365; grandis 250, 267, 365
 Lansium 252, 255, 364; anamallayanum 255; domesticum 255
 Lantana 299, 300, 301; aculeata 300;

- Lantana (cont.) *camara* 300; *indica* 300; *trifolia* 300, 301
 Laportea 140; *crenulata* 140; *pterostigma* 140
 Larix 9, 12, 18, 19; *griffithiana* 19; *griffithii* 19
 Lasianthus 289
 Lasiococca 170, 182; *symphylliaefolia* 182
 Lasiosiphon 147, 148; *eriocephalus* 148
 Lauraceae 48, 51, 56, 57, 208, 363, 365, 367, 369, 374
 Laurales 47
 Lawsonia *alba* 323; *inermis* 323
 Lead tree 84
 Lecythidaceae 203, 205, 206
 Leea 244; *umbraculifera* 245
 Leguminosae 68, 363, 368
 Lepidobalanus 117
 Lepidodendron 35
 Lepsanthes 259, 260; *tetraphylla* 260
 Leptosporangiateae 2
 Leucadendron 208
 Leucaena 76, 84; *glauca* 84
 Leucoscepterum *canum* 334
 Lichenes 1, 2
 Licuala 346, 347; *peltata* 348; *spinosa* 348
 Lignosae 41
 Lignum-vitae 83
 Liliaceae 335, 337, 366, 367
 Liliales 337
 Liliiflorae 33
 Limonia *acidissima* 245
 Linaceae 165, 166
 Linderia 49, 51, 57, 367
 Linociera 276, 279; *malabarica* 279
 Linostoma 147; *decandrum* 147
 Lippia 299, 301; *citriodora* 301; *geminata* 301; *nodiflora* 301
 Litchi 259, 261; *chinensis* 261
 Lithocarpus 117
 Litsaea 49, 56; *chinensis* 57; *citrata* 56; *monopetala* 57; *polyantha* 57; *sebifera* 57
 Livistona 346, 347; *jenkinsiana* 347
 Lodoicea 343
 Loganiaceae 268, 269, 367
 Loganiales 268
 Lophopetalum 225, 226, 369, 371; *fimbriatum* 226; *littorale* 226; *wallichii* 226; *wightianum* 226, 365
 Loquat 66
 Loranthaceae 237
 Loranthus 238, 240; *scurrula* 238
 Lumnitzeria 210, 215; *coccinea* 215; *racemosa* 215
 Lycopodium 1
 Lyonia 197, 198; *ovalifolia* 120, 198; *villosa* 198
 Lysinachia 323
 Lythraceae (PLATE xxx), 320, 369, 371
 Lythrales 320
 Maba 45, 47
 Macaranga 170, 180, 181, 182, 364, 366; *denticulata* 130, 181, 182; *gamblei* 181; *indica* 181; *pustulata* 181; *roxburghii* 182; *tanaria* 182
 Mace 59
 Machilus 48, 49, 55, 366, 369; *bombicina* 55; *globosa* 55; *macrantha* 55, 365
 Madhuca 231, 232; *bourdillonii* 232, 233; *butyracea* 232; *latifolia* 232, 233; *longifolia* 232, 233; *malabarica* 232, 233
 Magnolia 42, 43; *grandiflora* 43
 Magnoliaceae 33, 35, 37, 38, 41, 42, 366, 371, 372, 374
 Magnoliales 6, 33, 35, 37, 38, 41
 Mahogany tree 256
 Mahonia 313; *acanthifolia* 313; *sikkimensis* 313
 Maidenhair tree 8
 Malabar Kino 90
 Malay Padauk 90
 Mallotus 167, 169, 180, 181, 186, 366; *albus* 180, 181; *aureo-punctatus* 180; *nepalensis* 181; *philippensis* 180, 181, 366, 368; *repandus* 181; *roxburghianus* 181
 Malpighiaceae 165, 368, 370, 374
 Malpighiales 165
 Malvaceae (PLATE xiv), 158, 164, 362, 364, 368, 369, 374
 Malvales 164
 Mangifera 31, 264, 266, 372; *indica* 266, 361
 Manglietia 42, 43; *hookeri* 43
 Mango tree 266
 Manihot 170, 184, 364; *glaziovii* 184; *utilissima* 184
 Manila Hemp 336
 Manilkara 231, 234; *hexandra* 234, 235; *kauki* 234; *littoralis* 234, 235; *roxburghiana* 234, 235
 Mansonia 162
 Maoutia *puya* 141
 Margosa 254
 Marian tree 268
 Markhamia 294, 296, 297; *platycalyx* 296; *stipulata* 296
 Marlea *begoniifolia* 102
 Marsdenia 288
 Martaban varnish 264
 Mastixia 99, 100; *arborea* 100; *meziana* 100; *pentandra* 100
 Masuri 62
 Mayodendron 370
 Mediterranean Cypress 23
 Melaleuca 204, 205; *leucadendron* 205
 Melanorrhoea 14, 263, 264, 265, 362, 365, 370; *usitata* 264
 Melanthesa 169, 176
 Melastoma 51, 204, 209, 367; *malabathricum* 209
 Melastomataceae 203, 208, 209, 367
 Melia 252, 253; *azedarach* 253, 254; *composita* 253; *dubia* 253
 Meliaceae (PLATE xxiv), 251, 362, 364, 366, 367, 371, 374
 Meliales 251
 Melicope 246

- Meliosma 262, 263; *pinnata* 263
 Melocalamus 357
 Melocanna 357; *bambusoides* 354, 357
 Memecylon 208, 209, 367; *edule* 209
 Menispermaceae 312, 313, 371
 Merbau tree 74
 Mesquite 76
 Mesua 201, 367; *ferrea* 201, 361, 362, 364, 367
 Metroxylon 341, 345
 Mexican Rubber tree 137
 Mezoneuron 69, 71, 368; *cucullatum* 71
 Michelia 43, 44; *cathcartii* 43; *cham-paca* 43; *fuscata* 43
 Micrococca 170, 182
 Micromelum minutum 246; *pubescens* 246
 Mignonette 317
 Milk Bush 171
 Millettia 86, 91; *atropurpurea* 91; *auriculata* 91; *pachycarpa* 91
 Millingtonia 294, 295, 298, 370; *hortensis* 295, 361
 Mimosa 75, 76, 84, 294; *himalayana* 84; *pudica* 84; *rubicaulis* 84
 Mimosaceae 68, 75, 82, 362, 366, 374
 Mimulus 231, 234; *elengi* 234; *hexandra* 234, 235; *kauhi* 234; *littoralis* 234, 235; *roxburghiana* 234, 235
 Mischocarpus 259, 260
 Mischodon 167, 169, 177; *zeylanicus* 177
 Mitragyna 290, 291; *parvifolia* 291; *rotundifolia* 291; *tubulosa* 291
 Monadelphina 29
 Monandria 29
 Monochlamydeae 32, 33, 34
 Monocotyledones 28, 29, 335
 Monocotyledons 30, 31, 32, 33, 34, 335, 349
 Monoecia 29
 Monopetalae 30
 Monotheca 230, 231, 235, 364; *buxifolia* 235
 Moraceae (PLATE x), 129, 132, 364
 Morinda 289
 Moringa 363, 366, 371; *concanensis* 151; *oleifera* 151; *pterygosperma* 151
 Moringaceae 150, 151, 370, 371
 Morus 132, 137, 363, 364; *alba* 137; *indica* 137; *laevigata* 137; *serrata* 137
 Mucuna 95; *pruriens* 95; *prurita* 95
 Muga silkworm 55, 57
 Mulberry 137
 Munronia 252, 253
 Murraya *exotica* 246; *koenigii* 246; *paniculata* 246
 Musa 336; *textilis* 336
 Mussaenda 289, 370
 Mustard tree 229
 Myrabolans 212
 Myrica *nagi* 112; *sapida* 112
 Myricaceae 112
 Myricales 112
 Myricaria 152
 Myristica 59, 361; *canarica* 59; *fragrans* 59
 Myristicaceae 48, 58, 363, 364, 372
 Myrsinaceae (PLATE xviii), 229, 374
 Myrsinales 229
 Myrtaceae 203, 204, 206, 208, 367, 374
 Myrtales 203
 Myxopyrum 51, 276, 279, 367; *smilacifolium* 279
 Nannorhops 346, 347; *ritchiana* 347
 Naravelia 311
 Naspatti 67
 Nauclea 290, 291; *missionis* 290; *orientalis* 290
 Neem 254
 Neolitsaea 49, 56, 367
 Neonauclea 290, 291, 371
 Neopeltandra 168, 174
 Nepenthaceae 314, 315
 Nepenthes 316, 317; *khassiana* 316
 Nephelium 259, 261, 361; *litchi* 259, 261; *longana* 261; *stipulaceum* 261
 Nerium 281, 285; *indicum* 285; *odorum* 285
 Nipa 346, 350; *fruticans* 350
 Nothopogia 264, 266, 365
 Notonia 364; *grandiflora* 328
 Nutmeg 59
 Nyctaginaceae 146, 148, 303
 Nyctanthes 276, 278; *arbor-tristis* 278
 Nymphaeaceae 38
 Nyssa 99, 100; *bifida* 101; *javanica* 100, 101; *megacarpa* 101; *sessiliflora* 101
 Nyssaceae (PLATE v), 101
 *
 Oak 116
 Ochlandra 357
 Ochna 188; *beddomei* 188; *gamblei* 188; *heyneana* 189; *pumila* 189; *squarrosa* 188, 189; *wightiana* 189
 Ochnaceae 187, 188
 Ochradenus 317; *baccatus* 317
 Ochrocarpus 201, 202, 364; *longifolius* 202
 Ochroma *lagopus* 163
Odina wodiier 267
 Olacaceae (PLATE xvii), 235
 Olacales 235
 Olax 236
 Olea 276, 278; *cuspidata* 235, 278; *dioica* 278; *europaea* 279; *ferruginea* 278, 279; *glandulifera* 278, 279
 Oleaceae (PLATE xxix), 268, 276, 367, 369, 370, 374
 Oleander 285
 Oligomeris 317
 Opuntia 157; *dillenii* 157; *elatiar* 157; *monacantha* 157
 Orchid tree 164
 Orchidaceae 32, 337
 Oreocnide 140; *frutescens* 140; *integrifolia* 140

- Oreodoxa regia* 342, 361
Ormosia 85, 87; *robusta* 87; *travancorica* 87
Oroxylum 294, 370, 371; *indicum* 294, 298, 366
Osbeckia 204, 209, 367
Ostodes 170, 183; *paniculata* 183; *zeylanicus* 183
Osyris 238, 239; *wightiana* 239
Ougeinia 86, 94; *dalbergioides* 94, 215, 363, 364, 365
Oxalidaceae 332

Pachylarnax 42, 43; *pleiocarpa* 43
Padri wood 298
Paederia 289
Pagiantha 281, 284; *dichotoma* 284
Pagoda Flower 283
Pajanelia 294, 298, 370; *longifolia* 298; *rheedii* 298
Palaquium 231, 234, 362; *bourdillonii* 234; *ellipticum* 234; *polyanthum* 234
Palas 92
Palmaeae 335, 340
Palmales 340
Palmetto palm 347
Palmyra palm 345, 347
Pan 350
Pandanaceae 351
Pandanales 351
Pandanus 351, 361, 362
Papaveraceae 364
Papilionaceae 68, 85, 95, 153, 364, 375
Para Rubber tree 172
Parashorea 190, 196; *lucida* 196; *stellata* 196
Parastyrax 104
Parinari 63; *indica* 63; *travancorica* 63
Parishia 263, 264, 267; *insignis* 267, 364
Parlia 75, 76, 77, 362, 368; *javanica* 78; *roxburghii* 78
Parkinsonia 69, 72; *aculeata* 72
Parmentiera cereifera 298
Parrotia 106; *jacquemontiana* 106
Parsnip 325
Parsonsia 281, 284; *spiralis* 284
Pasania 118
Passifloraceae 154
Passiflorales 154
Passion Flower 155
Pat silkworm 56
Pavetta 289
Peach 64
Pear 67
Peganum 245
Peltophorum ferrugineum 75; *inermis* 75
Pemphis 320; *acidula* 320, 333
Pentace 158, 159, 370; *burmanica* 159
Pentacme 14, 190, 196; *siamensis* 196
Pentaptera tomentosa 212
Pentapterygium 199
Pereskia 156; *bleo* 157

Perfectae 28
Periploca hydaspidis 25
Persian Lilac 253
Personales 33, 329
Petrea 300, 306, 371; *volubilis* 306
Peucedanum sativum 325
Phacellaria 238, 240
Phanerogams 1, 2, 5
Philadelphus 96, 97; *coronarius* var. *tomentosus* 97; *tomentosus* 97
Phlogacanthus thyrsiflorus 331
Phoebe 49, 55; *angustifolia* 55; *attenuata* 55, 56; *cooperiana* 55, 56; *goalparensis* 55, 56; *hainesiana* 55, 56; *lanceolata* 50, 55; *pallida* 55
Phoenix 346, 348, 349; *acaulis* 348, 349; *dactylifera* 345, 348, 349; *farinifera* 349; *humilis* 348, 349; *paludosa* 349, 350; *pusilla* 349; *robusta* 348, 349; *sylvestris* 345, 348, 349
Photinia 63, 67
Phyllanthus 168, 174, 176; *emblica* 175; *indicus* 175
Physic Nut 183
Picea 9, 12, 15, 371; *morinda* 15, 17; *morindoides* 16; *smithiana* 15, 17, 18; *spinulosa* 15, 16
Picrasma 247, 248; *excelsa* 248; *javanica* 248; *quassiodoides* 248
Pieris 197, 198; *formosa* 198; *ovalifolia* 120, 198
Piliostigma malabaricum 70
Pimpernel 323
Pinaceae 9, 12
Pinanga 346, 350
Pinus 9, 12, 363, 371; *excelsa* 13, 18; *gerardiana* 13; *insularis* 13, 14, 118, 119, 198, 300, 349; *khasya* 14; *longifolia* 14, 120; *merkusii* 13, 14; *roxburghii* 13, 14, 282, 349; *wallichiana* 13, 18, 237
Pipal 135
Piper betel 350
Piptadenia 75, 76; *oudhensis* 76
Piptanthus 85, 87; *nepalensis* 87
Pirus 67
Pisonia 148; *aculeata* 148, 303; *excelsa* 148
Pistacia 263, 264, 267; *integerrima* 267
Pitcher Plant 316
Pithecellobium 76, 79, 369; *angulatum* 79, 80; *bigeminum* 79, 80; *dulce* 79; *lobatum* 79, 80; *montanum* 79; *subcoriaceum* 79; *umbellatum* 79
Pittosporaceae 149
Pittosporales 149
Pittosporum floribundum 150; *nepaulense* 150
Planchonia 206, 207, 368; *andamanica* 207; *valida* 207
Platanaceae 105, 107
Platanus orientalis 107, 363
Plecosperrum 132, 138; *andamanicum* 138; *spinosum* 137, 138
Plectocomia 341, 347, 351

- Plectocomiopsis 341, 347, 351
 Plectronia 292; didyma 292
 Pleiogynium cerasiferum 268
 Pleurostyliia 225, 226; wightii 226
 Plum 64
 Plumbaginaceae 323, 324
 Plumeria 279, 280, 282; acuminata 282; *acutifolia* 282; *rubra* 283
 Podocarpaceae 9, 10
 Podocarpus 9, 10; *cupressinus* 11; *imbricatus* 10, 11; *latifolia* 11; *neriifolius* 10, 11; *neriifolius* var. *brevifolius* 11; *wallichianus* 9, 10, 11
 Podophyllum emodi 313
 Poeciloneuron 201, 203, 361, 367; *indicum* 203, 362; *pauciflorum* 203
 Poinciana regia 71
 Poinsettia 172
 Poison-ivy 263
 Polemoniales 33
 Polyadelphia 29
 Polyalthia 44, 361; *longifolia* 44, 361
 Polyandria 29
 Polycarpicae 33
 Polygala 154; *arillata* 154; *karensium* 154
 Polygalaceae 153, 370, 372
 Polygalales 153
 Polygonaceae 25, 318
 Polygonales 318
 Polygonum 318
 Polypetalae 30, 32, 33, 34
 Pomegranate 223
 Pongamia 86, 87; *glabra* 88; *pinnata* 88, 248
 Poon tree 202
 Populus 108, 111, 367; *alba* 111; *balsamifera* 111; *ciliata* 111, 112; *euphratica* 111; *gambeli* 111, 112; *glauca* 111, 112; *microcarpa* 111; *nigra* 111; *nigra* var. *pyramidalis* 111
 Potato tree 328
 Potentilla 62, 63, 65
 Pouteria 231; *tomentosa* 231; *tomentosa* var. *elengioides* 231
 Premna 300, 302, 365; *bengalensis* 302; *herbacea* 302
 Prickly Pear 157
 Primula 323
 Primulaceae 230, 323
 Primulales 323
 Prinsepia 63, 65; *utilis* 65
 Pronuba yuccasella 339
 Prosopis 75, 76; *glandulosa* 76; *juliflora* 76; *juliflora* var. *glandulosa* 76; *spicigera* 76, 150, 229
 Prosorus 168, 174, 175; *indicus* 175
 Proteaceae 148, 371
 Proteales 148
 Protium 249, 250; *caudatum* 250; *serratum* 250
 Prunus 17, 63, 64, 65; *amygdalus* 65; *armeniaca* 64; *avium* 65; *campanulata* 64; *cerasifera* 65; *cerasoides* 64, 363; *cerasus* 65; *cornuta* 64, 65; *jacquemontii* 64; *martabanica* 65; *padus* 65; *persica* 64; *prostrata* 64; *puddum* 64;
 Pseudoglochidion 168, 174; *anamala-*
yanum 174
 Pseudostreblus 133
 Psidium 201; *guajava* 204
 Pteridium aquilinum 2
 Pteridophyta 1, 2
 Pteridospermae 35
 Pteridosperms 35
 Pterocarpus 86, 89, 368; *dalbergioides* 89, 90, 364; *indicus* 89, 90; *macro-*
carpus 89, 90; *marsupium* 89, 90;
santalinus 89, 90
 Pterolobium 69, 71, 368
 Pterospermum 160, 162, 362, 371;
acerifolium 162
 Pterygota 161; *alata* 161, 361, 369
 Ptychoraphis 346, 350; *augusta* 350
 Punica granatum 223
 Punicaceae 203, 223, 320
 Purkayasthaea 49, 57; *pseudomicro-*
pura 57
 Purple Wreath 307
 Putranjiva 169, 177; *roxburghii* 177
 Pygeum 63, 65, 365; *acuminatum* 65;
wightianum 65
 Pyinkado 77
 Pyracanthus crenulatus 67
 Pyrularia 238, 239; *edulis* 239
 Pyrus 63, 67; *communis* 67; *foliolosa*
 67; *malus* 67; *microphylla* 67;
pashia 67; *sinensis* 67; *wallichii* 67
 Quercus 17, 116, 123, 198; *acuminata*
 118, 122; *amherstiana* 118, 122;
brandisiana 117, 120; *dealbata* 118,
 122, 123; *dilatata* 117, 119;
eumorpha 118, 123; *fenestrata* 118,
 122; *floribunda* 119; *glauca* 117,
 120; *griffithii* 117, 119, *helferiana*
 117, 121; *ilex* 117, 119, 278; *incana*
 117, 119, 120; *lamellosa* 117,
 120, 121, 367; *lanceaefolia* 116,
 117, 121; *lanuginosa* 117, 119;
lappacea 118, 122; *lindleyana* 118,
 121; *lineata* 117, 120; *lineata*
 var. *griffithii* 120; *lineata* var. *hill-*
debrandii 121; *lineata* var. *lobbii*
 120; *lineata* var. *oxydodon* 120;
lineata var. *thomsoniana* 121; *mes-*
pilifolia 117, 121; *milroyi* 117, 121;
pachyphylla 118, 122; *pachyphylla*
 var. *fruticosa* 122; *patkoiensis* 117,
 120; *polystachya* 118, 122; *robur*
 260; *semecarpifolia* 117, 118;
semiserrata 116, 117, 120; *serrata*
 117, 118, 119; *spicata* 118, 122;
thomsoni 118, 123; *truncata* 117,
 121; *velutina* 116, 117, 121; *xylo-*
carpa 117, 121
 Quillaja saponaria 68
 Quince 66
 Quisqualis 210, 215; *indica* 215
 Radermachera 294, 297, 298; *amoena*
 298; *gigantea* 298; *xylocarpa* 298

- Rain tree 80
 Ramie grass 141
 Ranales 33, 34, 35, 37, 311
 Randia 290, 292; *dumetorum* 292
 Rangoon climber 216
 Ranunculaceae 31, 33, 35, 37, 311,
 312, 370
 Raspberry 65
 Rauwolfia 279, 280, 283; *serpentina*
 283
 Ravenala madagascariensis 336
 Red Bombwe 207
 Red Kutch 83
 Red Sandal wood 77
 Red Sanders 90
 Reidia 168, 174, 175
 Reinwardtia trigyna 166
 Rejoua 281, 284; *dichotoma* 284
 Reptonia buxifolia 235
 Reseda odorata 317
 Resedaceae 317, 371
 Resedales 317
 Retama 72
 Rhabdia 273; *lycioides* 276
 Rhamnaceae (PLATE XX), 240, 244,
 367, 370, 375
 Rhamnales 240
 Rhamnus 241
 Rhaps 346, 347; *flabelliformis* 347
 Rhazya 279
 Rhea Grass 141
 Rheum 318; *rhaponticum* 318
 Rhipsalis 157
 Rhizophora 216, 217, 218, 219, 362;
 candelaria 219, 220; *conjugata* 220;
 mucronata 219
 Rhizophoraceae 203, 216, 217, 289,
 362, 366, 367
 Rhododendron 197, 198, 209; *arbo-*
 reum 118, 119, 120, 198; *nilagiricum*
 198
 Rhodomyrtus 51, 204, 208, 367;
 tomentosa 204
 Rhubarb 318
 Rhus 264, 265, 364, 368; *cotinus* 265;
 semialata 265; *toxicodendron* 263
 Ribes 96, 98; *alpestre* 98; *glaciale* 98;
 nigrum 98; *orientale* 98; *rubrum* 98
 Ricinus 170, 183; *communis* 183
 Rinorea 153; *bengalensis* 153
 Rosa 63, 65; *involucrata* 66; *longicus-*
 pis 66; *macrophylla* 65; *moschata*
 66; *sericea* 66; *webbiana* 65
 Rosaceae 62, 105, 188, 320, 369
 Rosales 33, 62
 Rose-Apple 205
 Rose Sandalwood 278
 Rotula 273, 276; *aquatica* 276
 Roystonea regia 342, 361
 Rubia 289; *cordifolia* 289
 Rubiaceae 216, 288, 289, 290, 293,
 366, 370, 371, 375
 Rubiales 33, 288
 Rubus 63, 65; *idaeus* 65
 Rue 245
 Ruscaceae 337, 339
 Ruscus hypophyllum 339
 Rusty Shield-bearer 75
 Ruta 245; *graveolens* 245
 Rutaceae (PLATE XXI), 245, 247, 367
 Rutales 245
 Sabai grass 353
 Sabal 346, 347; *adansonii* 347;
 palmetto 347
 Sabia 262, 263
 Sabiaceae 258, 262
 Saccharum spontaneum 152
 Sageretia 241; *brandrethiana* 235
 St. Thomas' Bean 77
 Salicaceae (PLATE VII), 33, 108
 Salicales 34, 108
 Salix 108, 361; *acmophylla* 109; *alba*
 110; *alba* var. *caerulea* 110; *baby-*
 lonica 110; *calyculata* 110; *caprea*
 110; *daltoniana* 109; *daphnoides*
 109; *denticulata* 109; *eriphylla*
 110; *eristachya* 110; *flabellaris*
 109; *fragilis* 110; *furcata* 109;
 hastata 109; *lindleyana* 109; *longi-*
 flora 109; *obscura* 110; *oreophila*
 110; *serpyllum* 110; *sikkimensis*
 110; *tetrasperma* 109; *thomsoniana*
 110; *viminialis* 109; *x viridis* 110;
 wallichiana 109
 Salmalia 162, 164, 362, 363, 366, 369;
 malabarica 163, 361
 Salopa fibre 348
 Salsola 319, 371
 Salvadora 229; *oleoides* 150, 229;
 persica 229
 Salvadoraceae 224, 228
 Samadera 246, 247, 370; *indica* 247
 Samanea saman 80
 Sambucus 290, 293
 Samydaceae 142, 143, 367, 372
 Sand Pear 67
 Sandalwood tree 238
 Sandoricum 252, 254; *indicum* 254;
 koetjape 254
 San-hemp 92
 Sansevieria 339, 340; *roxburghiana*
 340
 Santalaceae 237, 238
 Santalales 237
 Santalum 238; *album* 238
 Sapindaceae (PLATE XXV), 258, 259,
 261, 262, 369, 370, 371, 372
 Sapindales 258
 Sapindus 259, 261; *detergens* 261;
 emarginatus 261; *laurifolius* 261;
 trifoliatus 239, 261
 Sapium 170, 185, 368; *baccatum* 186;
 eugeniifolium 185, 186; *indicum*
 186; *insigne* 185, 186; *sebiferum*
 185, 186
 Sapotaceae (PLATE XIX), 229, 230, 288,
 362, 364
 Sapia 315; *himalayana* 244, 315
 Saraca 69, 74; *indica* 74, 363
 Sarcocephalus cordatus 290; *missionis*
 290
 Sarcosperma 230, 231, 232; *arborescens*
 232; *griffithii* 232

- Sarcostigma kleinii 228
 Sarraceniales 324
 Satinwood 253
 Sauropus 169, 176
 Sausage tree 295
 Scaevola 326; koenigii 326; plumieri 326
 Scaphula 190
 Schefflera venulosa 103
 Schima 188, 371; khasiana 188; wallichii 122, 187, 365, 369
 Schinus molle 268
 Schleicheria 259, 260; oleosa 260; trijuga 260
 Schrebera 276, 277, 369; swietenoides 277
 Scleropyrum 238, 239, 363; ridleyi 239; wallichianum 239
 Scolopia 143, 145; crenata 145
 Scoparia 329
 Scrophulariaceae 31, 329
 Scurrula parasitica 238
 Scyphiphora 215
 Securidaca 154, 370; tavoyana 154
 Securinega 175
 Semecarpus 264, 266, 365; albescens 267; anacardium 266, 267; auriculata 266, 267; heterophylla 267; kurzii 267; pandurata 267; panduriformis 267; prainii 267; subracemosa 267; travancorica 266, 267
 Sensitive Plant 84
 Serissa 289
 Sesbania 86, 91; aculeata 92; aegyptiaca 91; bispinosa 91, 92; cannabina 91, 92; grandiflora 91; sesban 91; sesban var. bicolor 92; sesban var. picta 92
 Sequoia sempervirens 20
 Shorea 14, 190, 194, 195, 363; assamica 195; gratissima 195, 196; oblongifolia 195; reticulata 195; robusta 194, 195, 321, 349; stipularis 195; talura 195; tumbuggaia 195
 Sida 165
 Sideroxylon 231; longipetiolatum 186; tomentosum 231
 Silk-Cotton tree 143
 Silver Fir 17
 Silver Mimosa 81
 Silver Wattle 81
 Simarubaceae (PLATE XXII), 245, 246, 368, 370
 Simul tree 163
 Siphonodon 225, 227; celastrinus 227
 Skimmia laureola 246
 Sloanea 159, 371
 Smilacaceae 337, 338
 Smilax 279, 367
 Solanaceae (PLATE XXXI), 328
 Solanales 328
 Solanum 328; macranthum 328
 Sonerila 208
 Sonneratia 217, 218, 221, 222, 362; acida 221; alba 221; apetala 221, 222; caseolaris 221; griffithii 221
 Sonneratiaceae 203, 221, 320, 362
 Sophora 85, 87, 369; griffithii 87; tomentosa 333
 Sorbus 67; cashmiriana 67; foliolosa 67; microphylla 67; wallichii 67
 Sour Sop 44
 Soyimida 253, 256, 371; febrifuga 253, 256
 Spanish Broom 95
 Spar tree 202
 Spartium junceum 95
 Spathodea 297; campanulata 298
 Spatholobus 86, 93, 364; roxburghii 93
 Spermatophyta 1, 2
 Sphagnum 324
 Sphenodesme 300, 307, 371
 Spiraea 62, 68; cantoniensis 68
 Spondias 264, 267, 365; mangifera 267; pinnata 267
 Star Apple 231
 Star Gooseberry 175
 Stellaria 28
 Stephygyne 291; diversifolia 291; parvifolia 291; tubulosa 291
 Sterculia 161, 362; alata 161; campanulata 161; colorata 161, 370; urens 249, 250
 Sterculiaceae 157, 158, 160, 362, 368, 369, 370, 371, 375
 Stereospermum 294, 297, 361, 371; angustifolium 297, 298; chelonoides 297; hyposticum 298; personatum 297; suaveolens 297; tetragonum 297; xylocarpum 298
 Stilbanthus scandens 319
 Strawberry tree 100
 Streblus 133, 139, 364; asper 139
 Strobilanthes 331; flaccidifolius 331; wallichii 331
 Strombosia 236, 368; ceylanica 236, 365; leprosa 236
 Strophanthus 281, 282, 285, 286; brevicaudatus 286; caudatus 285, 286; dichotomus 286; griffithii 286; longicaudatus 286; perakensis 286; scandens 285, 286; singaporianus 285, 286; wallichii 285; wightianus 285
 Strychnine tree 272
 Strychnos 51, 239, 269, 271, 272, 367; aenea 271, 272; andamanensis 271, 272; axillaris 271, 272; bicirrhosa 271, 272; cinnamomifolia 272; colubrina 271, 272; dalzellii 271, 272; laurina 271, 272; lenticellata 271, 272; nux-blanda 271, 272; nux-vomica 239, 271, 272; potato-rum 271, 272; tubiflora 272; wallichiana 272
 Stylocoryne 289
 Styracaceae 103, 105
 Styralces 103
 Styra 104; benzoin 104; hookeri 104; rugosum 104; serrulatum 104
 Suaeda 319, 371
 Sugar Maple 262

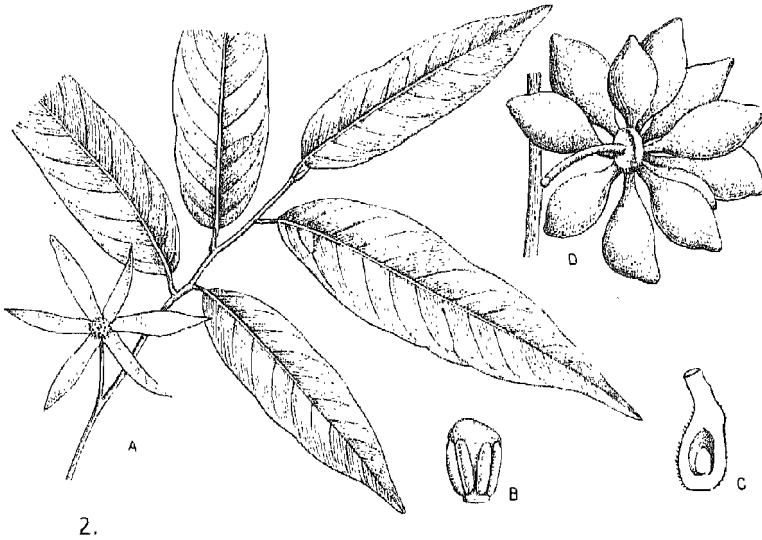
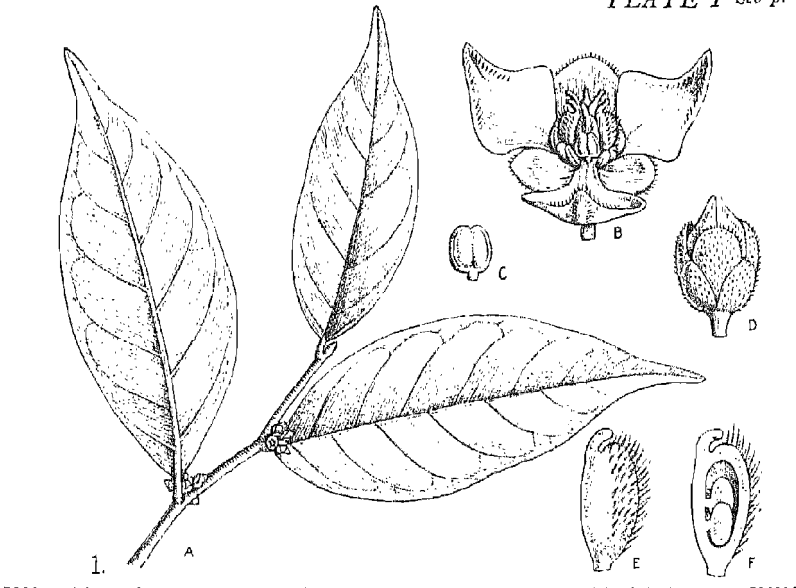
- Sumbavia 170, 186; *macrophylla* 186
 Sundew 324
 Sundri tree 161
 Sunn-hemp 92
 Sweet Cherry 65
 Swietenia 253, 256; *macrophylla* 256;
 mahogani 256
 Swintonia 263, 264, 265, 365, 370;
 floribunda 265
 Sycamore 262
 Symphorema 300, 307, 371; *involu-*
 cratum 307; *polyandrum* 307
 Symphyllia 169, 180; *mallotiformis*
 180
 Symplocaceae 103, 104, 105
 Symplocos 105, 154; *beddomei* 105;
 reticulata 105; *spicata* 105
 Syndiclis 48, 51; *paradoxa* 51
 Syngenesia 29
 Syringa 276, 278; *emodi* 278; *vulgaris*
 278
 Syzygium 204; *cumini* 205; *jambos*
 205

 Tabashir 355
 Tabernaemontana 284; *coronaria* 284;
 dichotoma 284; *divaricata* 284
 Taiwania 9, 19, 20; *cryptomerioides* 20,
 21
 Talauma 42, 43; *phellocarpa* 43
 Talipot 341, 348
 Tamaricaceae 152, 366, 372
 Tamaricales 152
 Tamarindus 69, 73; *indica* 73, 361
 Tamarix 111, 127, 152, 320, 372;
 articulata 152; *dioica* 152; *salina*
 152; *troupilii* 152
 Tapioca plant 184
 Taraktogenos *kurzii* 144
 Taxaceae 9, 10
 Taxodiaceae 9, 19
 Taxodium 9, 19; *distichum* 20; *disti-*
 chum var. *mucronatum* 20; *mucro-*
 natum 20
 Taxus 9, 10, 11; *baccata* 10
 Tecoma *undulata* 295
 Tecomeae 297
 Tecomella 294, 295, 298; *undulata* 295
 Tectona 299, 300, 301, 371; *grandis*
 301, 302; *hamiltoniana* 301, 302
 Temple flower 283
 Tenasserim Pine 14
 Terminalia 90, 159, 209, 210, 211, 216,
 362, 370; *alata* 211, 212, 213, 215;
 alata var. *tomentosa* 212; *alata* var.
 typica 212; *arjuna* 210, 212; *belle-*
 rica 210, 211; *bialata* 211, 213;
 catappa 210, 211, 368; *chebula* 80,
 210, 212; *coriacea* 211, 213;
 coriacea var. *peguensis* 213; *crenu-*
 lata 211, 213; *gella* 210, 212; *myrio-*
 carpa 211, 213; *pallida* 210, 211;
 paniculata 211, 213; *procera* 211;
 tomentosa 212; *travancoriensis* 210,
 212
 Ternstroemiaceae 187
 Tetracentron 38
 Tetradynamia 29
 Tetrameles *nudiflora* 155, 362, 363,
 364
 Thalictrum 311
 Thallopiphyta 1, 2
 Thallopiphytes 2
 Thatch grass 353
 Theaceae 187, 196, 369, 371
 Theales 187
 Theobroma *cacao* 161
 Thespesia 364; *lampas* 165; *populnea*
 165
 Thevetia 280, 282; *neriifolia* 282;
 peruviana 282
 Thunbergia 331
 Thuya 361
 Thymelaeaceae 146
 Thymelacales 146
 Thyrsostachys *oliveri* 356
 Tibouchina 209; *semidecandra* 209
 Tiliaceae (PLATE XII), 157, 158, 159,
 367, 368, 370
 Tiliales 157
 Toddalia *bilocularis* 246
 Toothbrush tree 229
 Tournefortia 333; *argentea* 321, 333
 Trachycarpus 346, 347; *martiana* 347
 Trametes *pini* 16, 17
 Traveller's tree 336
 Tree of Heaven 248
 Tree Tomato 328
 Trema 129; 130, 367; *amboinensis*
 130; *orientalis* 130; *politoria* 130
 Trewia 167, 169, 179, 180, 302; *nudi-*
 flora 179; *polycarpa* 179, 180
 Trigonostemon 170, 183
 Tritaxis 170, 183; *beddomei* 183
 Trochodendraceae 38
 Trochodendron 38
 Tsuga 9, 12, 14; *brunoniana* 14
 Tung oil 178
 Tupidanthus 103; *calyptratus* 103
 Turmeric 337
 Turraea 251, 252, 254; *villosa* 254

 Ulex *europaeus* 95
 Ulmaceae 129, 367, 370
 Ulmus 129, 370; *laevigata* 129; *lanci-*
 folia 129; *procera* 130; *villosa*
 129; *wallichiana* 129
 Umbellales 33, 325
 Umbelliferae 103, 325, 375
 Umbrella Thorn 82
 Uncaria 289
 Upas tree 138
 Urena 165
 Urostylis *punctigera* 43
 Urtica *parviflora* 141
 Urticaceae 129, 139, 141, 362
 Urticales 128

 Vacciniaceae 196, 199, 289
 Vaccinium 199; *donianum* 199;
 leschenaultii 199
 Vallaris 281, 284; *dichotoma* 284;
 heynei 284; *solanacea* 284

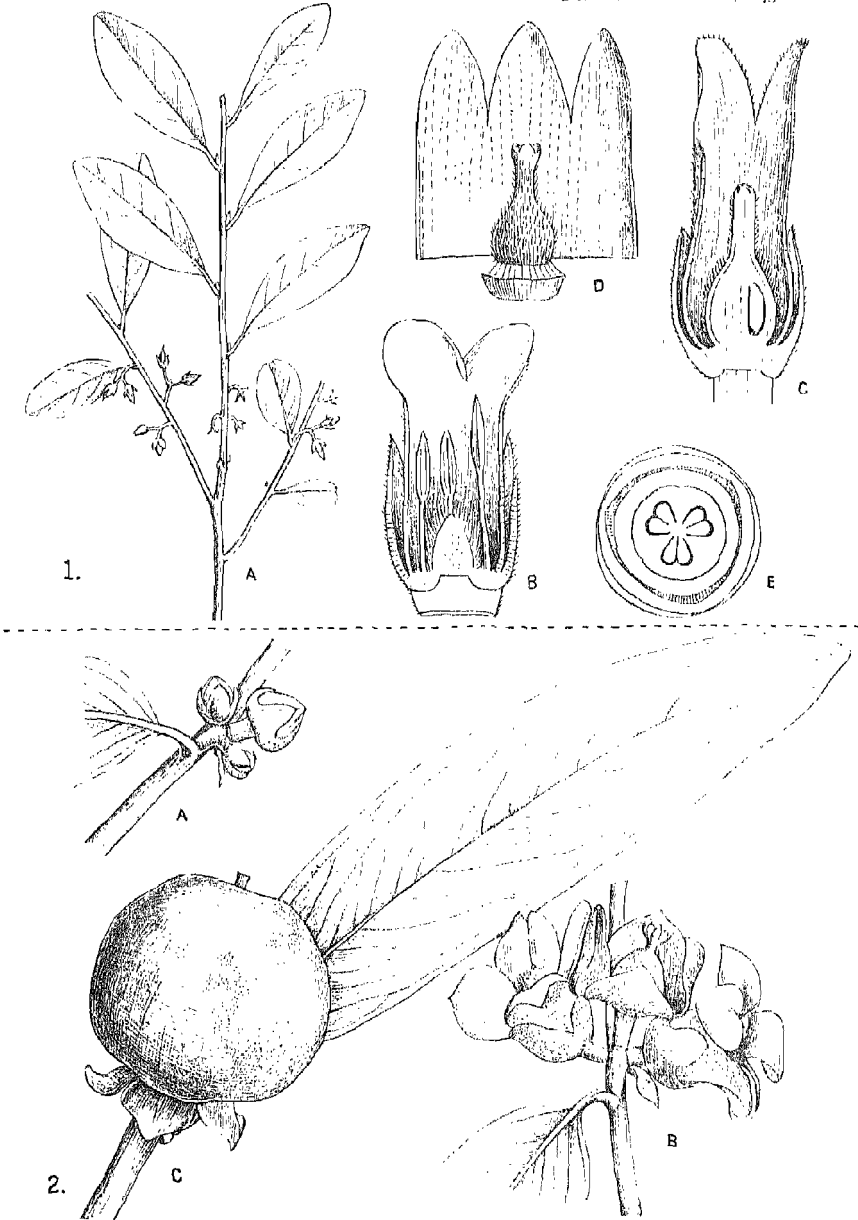
- Vateria 190, 194; indica 194
 Vatica 190, 196; lanceaefolia 196
 Ventilago 240, 241, 242, 370; maderaspatana 242
 Vepris bilocularis 246
 Verbenaceae 299, 362, 371
 Verbenales 299
 Vernonia 327; arborea 327, 328; monosis 327, 328; parryae 327, 328; shevaroyensis 327, 328; talaumifolia 327, 328; travancorica 327, 328; volkameriaefolia 327, 328
 Veronica 329
 Viburnum 293; colebrookianum 293
 Villebruneu 140; frutescens 140; integrifolia 140
 Viola 371
 Violaceae 153, 371
 Violales 153
 Viscum 238, 366
 Vitex 300, 304; altissima 304, 306; canescens 304, 305; diversifolia 305, 306; glabrata 305, 306; heterophylla 305; leucoxydon 305, 306; limoniifolia 304, 305; negundo 304, 305, 329; negundo var. incisa 305; peduncularis 305, 306, 366; pubescens 304, 305; quinata 304, 305; trifolia 304, 305; urceolata 305, 306; vestita 305, 306
 Vitis 244; elongata 244; planicaulis 244; repanda 244; vinifera 244
 Vogelia indica 324
 Wagatea 69, 72; spicata 72
 Walnut 126
 Walsura 252, 253, 257; piscidia 257
 Waras 94
 Washingtonia 346, 347; filifera 347
 West-Himalayan Fir 17
 White Chuglam 214
 White Dammar 190
 Whortleberry 199
 Wig Plant 265
 Wightia 329, 330; aplinii 330; gigantea 330; lacei 330; speciosissima 330
 Wikstroemia 147; canescens 147; indica 147
 Wild Cherry 65
 Wild Date Palm 349
 Winteraceae 38, 41, 42
 Wistaria sinensis 95
 Witch Hazel 106
 Wood Apple 245
 Woodfordia 320, 323; floribunda 323; fruticosa 323
 Wrightia 281, 284, 287; coccinea 284, 285, 287; tinctoria 284; tomentosa 284, 285
 Xanthophyllum 154
 Ximenia 236; americana 236
 Xylia 75, 77; dolabriformis 77, 322; xylocarpa 77
 Xylocarpus 253, 256; gangeticus 256, 257; granatum 256; molluccensis 256
 Xylosma 143, 145
 Yellow Oleander 282
 Yellow Silk-Cotton tree 142
 Yew tree 10
 Yucca 339, 340, 342; aloifolia 340; filamentosa 340
 Zanthoxylum 363; budrunge 246; rhetsa 246, 365
 Zedoary 337
 Zibetto 163
 Zingiberaceae 336, 337
 Zingiberales 335
 Zizyphus 240, 241, 329, 366, 367; incurva 241, 363; jujuba 241, 361
 Zollingeria 370
 Zygogynum 38



ANNONACEAE

1. *Orophaea thomsonii* Bedd. (After Beddome). A : Flowering twig showing inflorescence of fascicled flowers $\times 1$. B : Flower showing the six petals in two series, the inner series of which are clawed and cohere by the margins in the bud, the outer series similar to the sepals. Gynaeceum of separate ovaries ; androecium of definite stamens $\times 20$. C : Stamens with very short filament and connective which is not produced $\times 20$. D : Flower bud, showing sepals and the two series of petals $\times 20$. E & F : Ovary and section of the same showing the attachment of the ovules (two ovules can be seen out of the five or six present) $\times 40$.

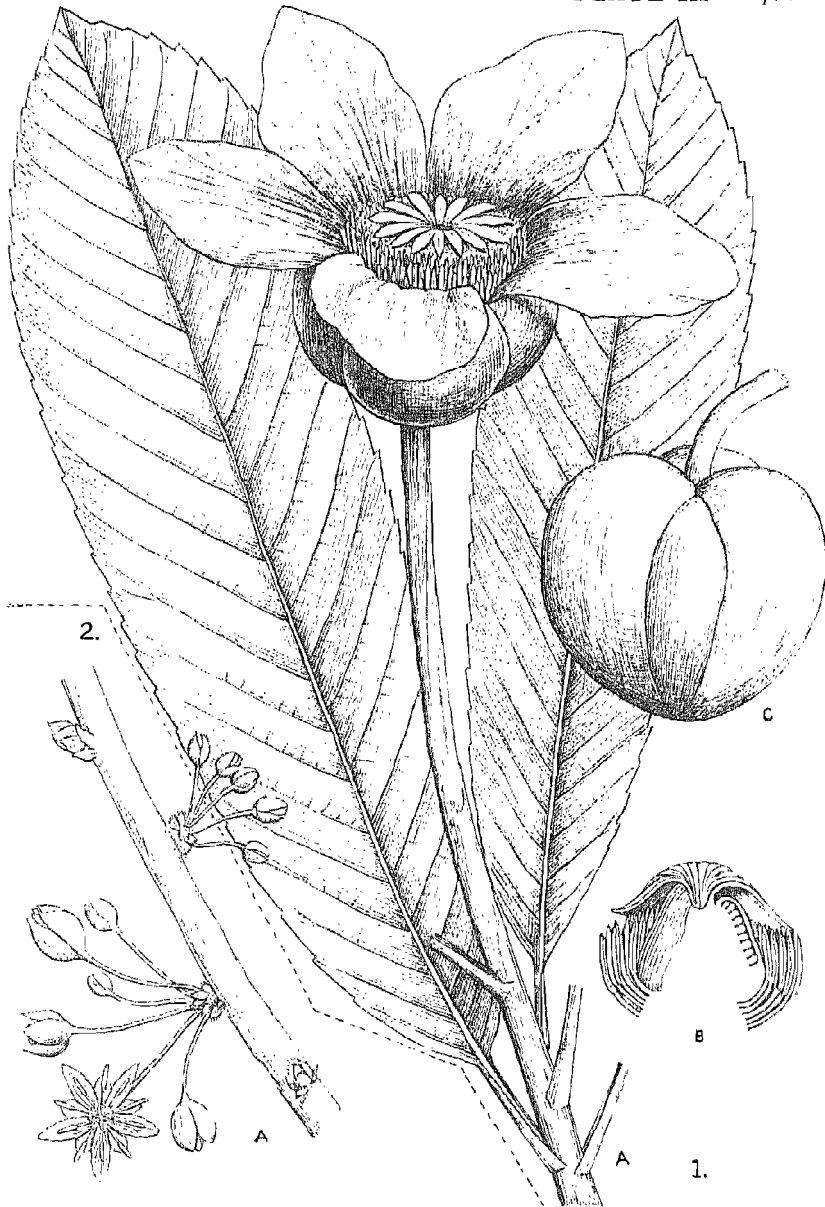
2. *Polyalthia coffeoides* Benth. et Hook. f. A : Flowering twig with a flower ; six petals are visible $\times 1/2$. B : Stamens showing the produced connective $\times 10$. C : Section of an ovary showing the sessile basal ovule $\times 10$. D : Fruit a ring of 1-seeded berries $\times 1/3$.



EBENACEAE

1. *Malaba buxifolia* Pers. A : Branch with male flowers $\times 1/2$. B : Longitudinal section of the male flower, showing calyx, corolla, stamens and pistillode $\times 8$. C : Longitudinal section of the female flower, showing calyx, corolla, and ovary with pendulous ovule ; staminodes absent $\times 8$. D : Female flower with corolla opened out showing pistil ; style 3-fid $\times 7$. E : Diagram of the female flower. (After Lecomte)

2. *Diospyros embryopteris* Pers. A : Twig with male flowers $\times 2$. B : Twig with female flowers $\times 2$. C : Fruit, covered with microscopic reddish-brown, glandular, unicellular hairs $\times 1/2$.

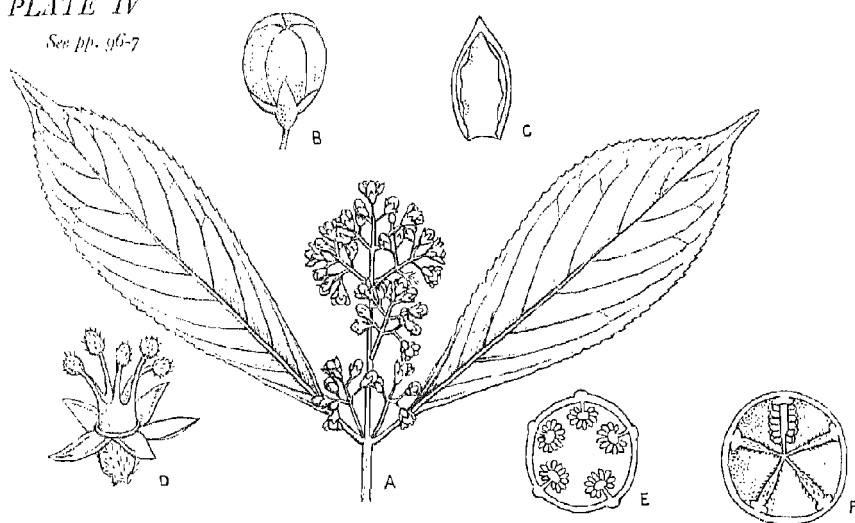


DILLENIACEAE

1. *Dillenia indica* Linn. A: Tip of flowering branch. Flower open, showing spreading styles, numerous stamens, large crumpled white petals and fleshy calyx lobes $\times \frac{1}{2}$. B: Section of the androecium and gynaecium $\times \frac{1}{2}$. C: Fruit formed of the enlarged fleshy sepals around the ripe carpels $\times \frac{1}{2}$.
2. *Dillenia pentagyna* Roxb. A: Flowers in clusters on tubercles on the branches $\times \frac{1}{2}$.
(After Roxburgh)

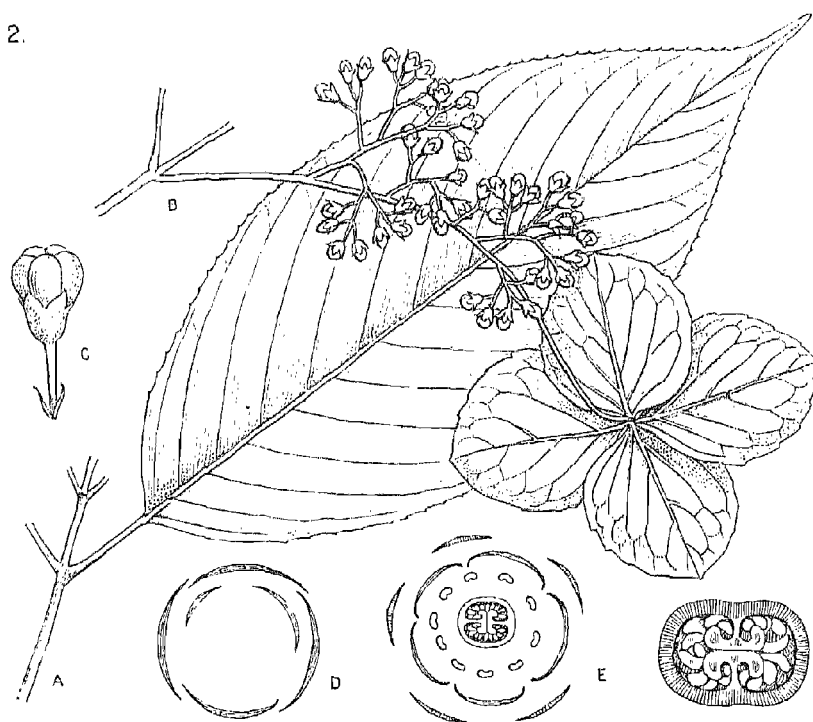
PLATE IV

See pp. 96-7



1.

2.



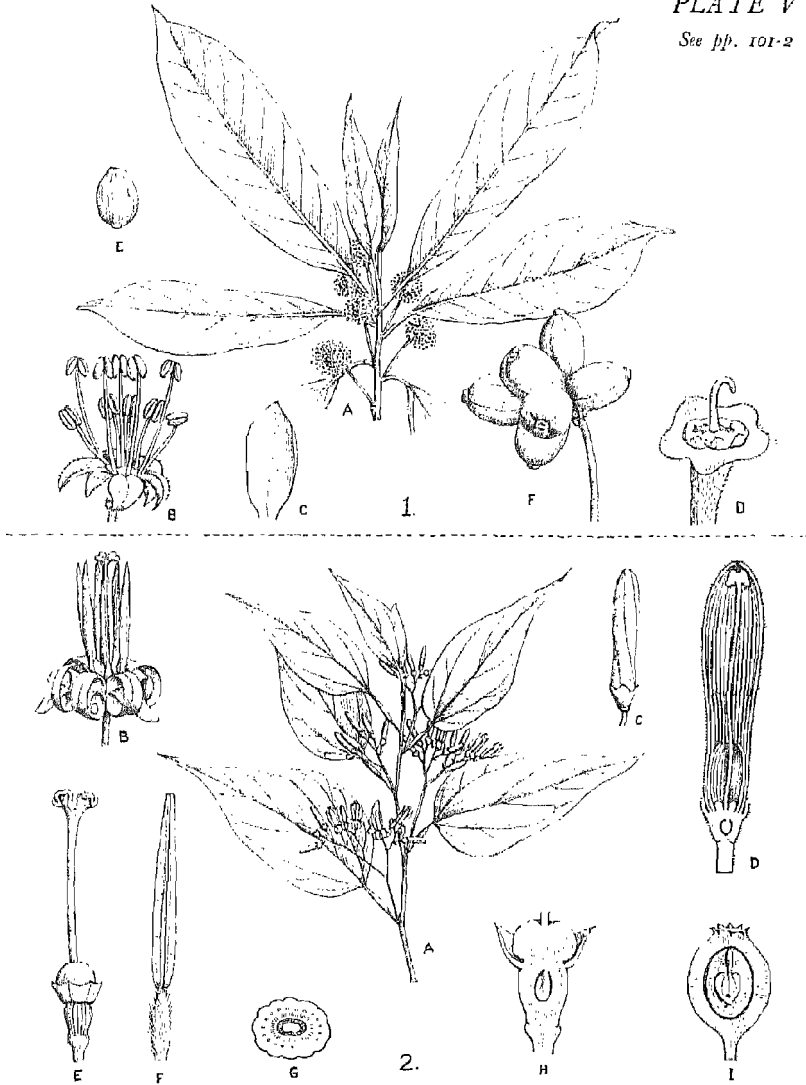
HYDRANGEACEAE

1. *Dichroa febrifuga* Lour. A : Flowering twig $\times \frac{1}{2}$. B : Flower-bud $\times 3$. C : Petal $\times 3$. D : Ovary, sepals and styles ; petals removed ; styles divergent, stigmatiferous at the apex $\times 3$. E : Cross section of the ovary at the middle showing the parietal placentae $\times 10$. F : Cross section of the ovary at the base $\times 10$. (After *Flor. Gén. de l'Indo-Chine*)

2. *Hydrangea robusta* Hook. f. et Thoms. A : Leaf $\times 1$. B : Inflorescence showing one sterile flower $\times 1$. C : Flower-bud $\times 4$. D : Diagram of the sterile flower. E : Diagram of a fertile flower. F : Cross section of the ovary $\times 20$.

PLATE V

See pp. 101-2



NYSSACEAE

1. *Nyssa javanica* (Bl.) Wang. A : Flowering twig ; male flowers in heads $\times \frac{1}{2}$. B : Male flower ; petals five, hairy ; stamens ten ; disk present ; pistillode absent $\times 5$. C : Petal $\times 15$. D : Female flower ; petals absent ; style simple $\times 8$. E : Seed $\times \frac{2}{3}$. F : Fruiting head $\times \frac{2}{3}$. (After Wangerin)

ALANGIACEAE

2. *Alangium begoniifolium* (Roxb.) Baill. A : Flowering shoot $\times \frac{5}{12}$. B : Flower, showing the revolute petals (6-8) ; stamens (6-8) with long anthers and short filaments $\times \frac{5}{3}$. C : Flower-bud ; aestivation contorted $\times \frac{5}{3}$. D : Section of the flower-bud $\times \frac{5}{4}$. E : Flower with stamens and petals removed, showing fleshy disk above the inferior ovary $\times \frac{5}{3}$. F : Single stamen ; filament hairy ; anthers long. G : Transverse section of the ovary $\times 3$. *Alangium salviifolium* (Linn.) Wang. H : Longitudinal section showing 1-locular ovary with one pendulous anatropous ovule $\times 4$. I : Longitudinal section of the seed $\times \frac{5}{4}$. (Both after Wangerin)

PLATE VI

See p. 99



ARALIACEAE

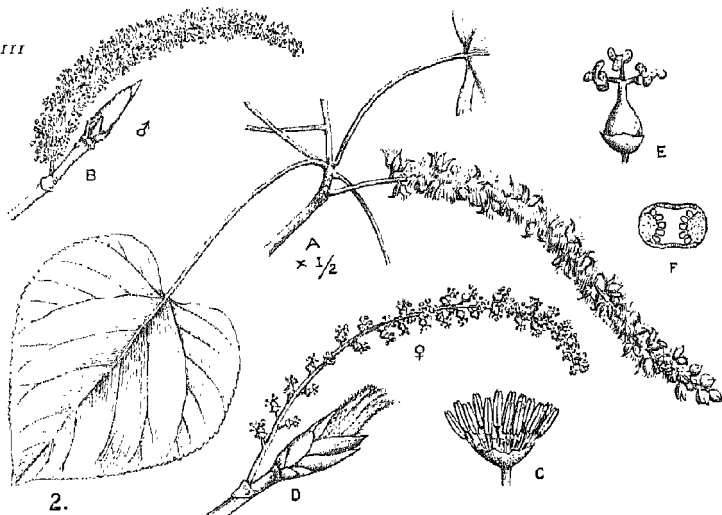
Hedera himalaica Tobler. A : Flowering twig, leaves dimorphic $\times 1$. B : Diagram of the flower ; sepals five ; petals five ; stamens five ; ovary 5-locular. C : Section of the flower showing inferior ovary with pendulous ovules $\times 4$. D : Fruit $\times 3$.

PLATE VII

See p. 109



See p. 111



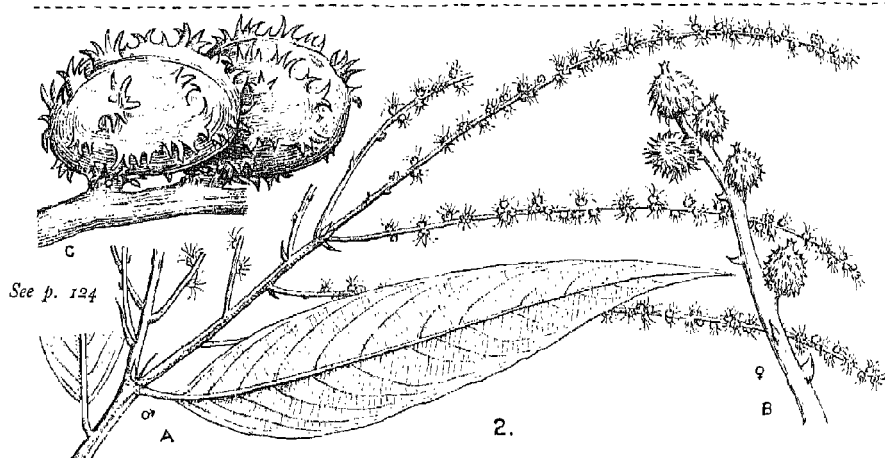
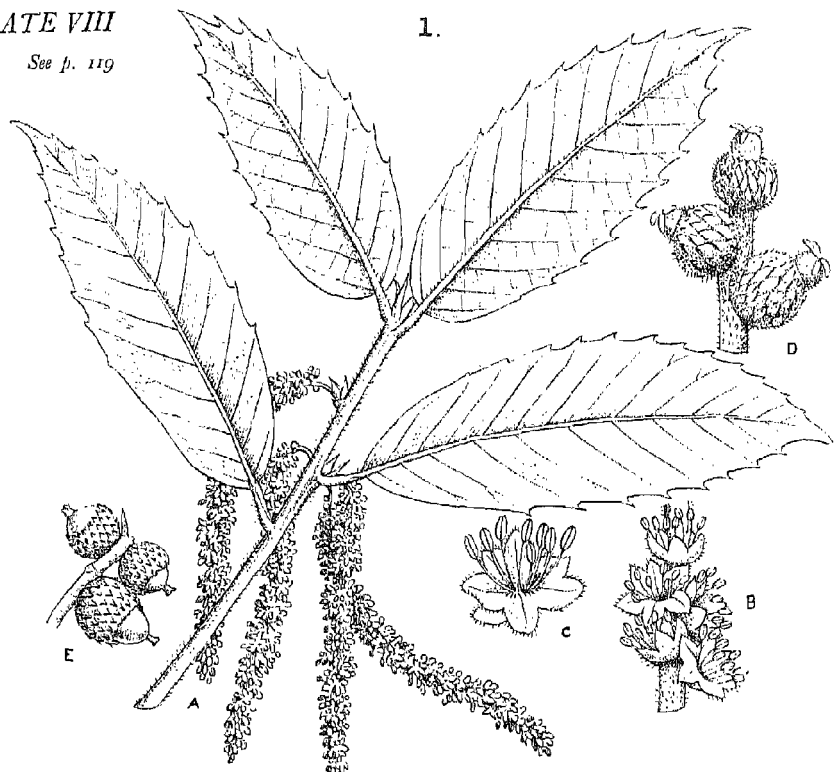
SALICACEAE

1. *Salix daphnoides* Vill. A : Twig with male catkins $\times \frac{1}{2}$. B : Twig with young female catkins $\times \frac{1}{2}$. C : Leafy twig $\times \frac{1}{2}$. D : Male flower ; a pair of stamens in a bract ; disk a solitary erect gland opposite to the bract $\times 10$. E : Female flower ; ovary seated in the axil of a bract ; disk half surrounding the ovary $\times 10$. (After Hegi)

2. *Populus ciliata* Wall. A : Fruiting twig ; the capsules are hidden by the silky seeds $\times \frac{1}{2}$. B : Male inflorescence $\times \frac{1}{2}$. C : Male flower. Stamens in a disk-like perianth $\times 10$. D : Female inflorescence $\times \frac{1}{2}$. E : Female flower ; ovary seated in a disk-like perianth ; styles and stigmas three $\times 10$. F : Cross section of the ovary, showing two parietal placentas $\times 20$.

PLATE VIII

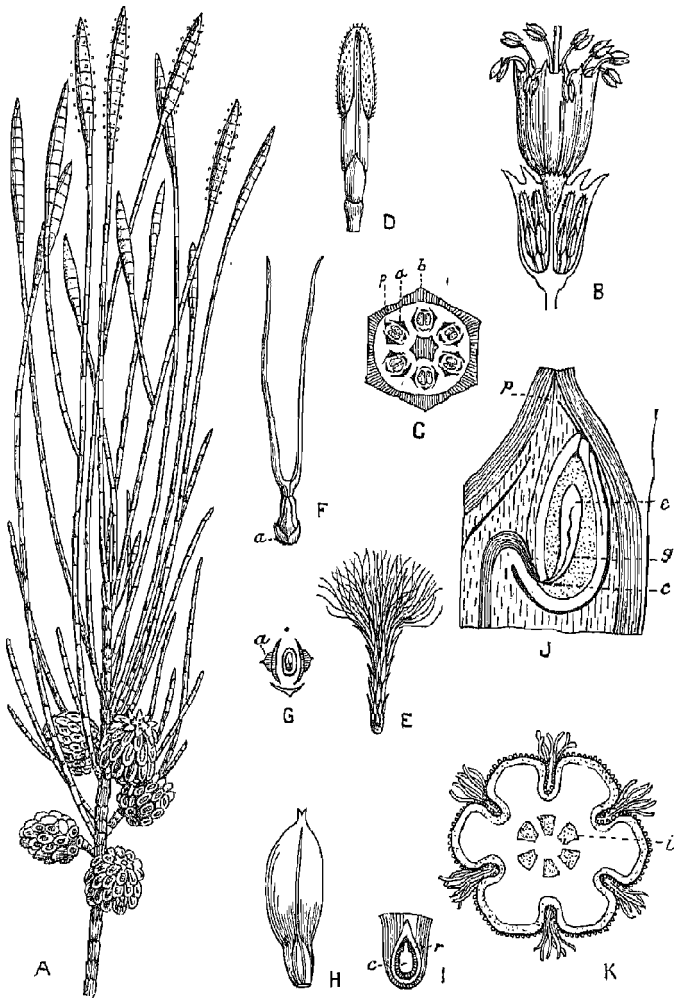
See p. 119



FAGACEAE

1. *Quercus lanuginosa* D. Don. A: Leafy branch with pendulous male catkins $\times 1$. B: Portion of the male catkin $\times 2$. C: Solitary male flower $\times 5$. D: Portion of the female spike $\times 2$. E: Ripe nuts showing the persistent style $\times 1$. (After King)

2. *Castanopsis armata* Spach. A: Branch with male spikes $\times 1\frac{1}{2}$. B: Portion of the female spike $\times 1$. C: Ripe fruits $\times 1$.

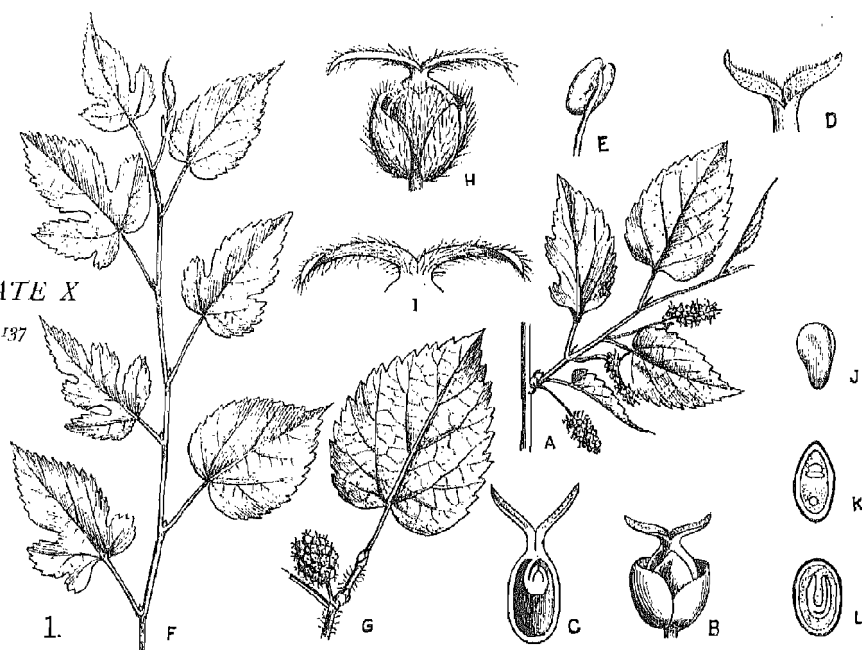


CASUARINACEAE

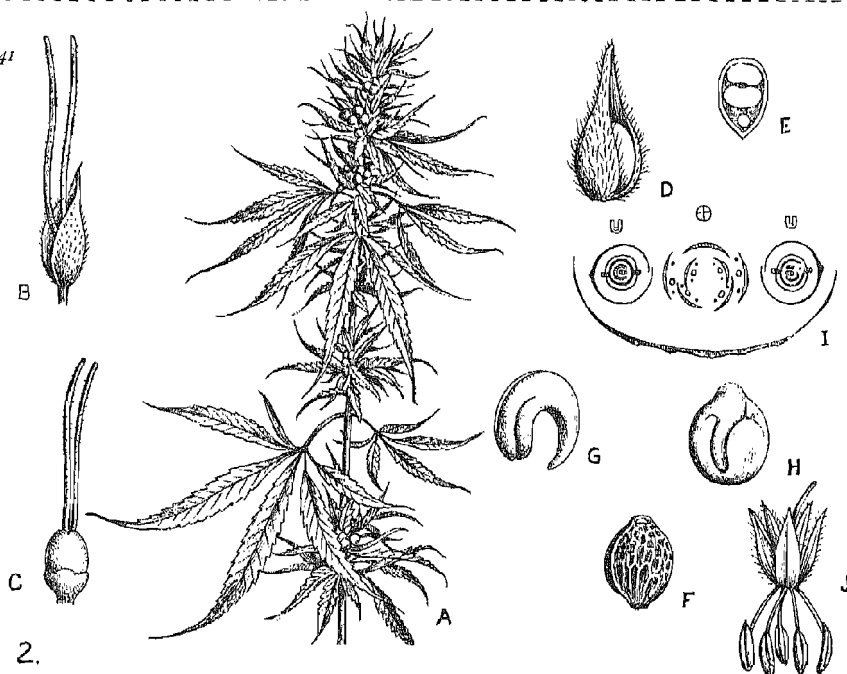
Casuarina equisetifolia Forst. A : Shoot with male inflorescences and fruits $\times \frac{2}{3}$, remainder variously enlarged. (After Rendle in *Families of Flowering Plants*). B : Portion of the male inflorescence, two whorls ; the lower sheath is cut open to show the young flowers. C : Diagram of a whorl of male flowers ; b. bract ; a. bracteole ; p. perianth. D : Male flower before the elongation of the filament ; the perianth leaves are carried up on the anther. E : Female inflorescence, with long protruding stigmas. F : Female flower ; a. bracteole. G : Diagram of same ; a. bracteole. H : Fruit. I : Lower portion of same with longitudinal section of seed ; r. radicle ; c. cotyledon. J : Portion of longitudinal section of an ovary showing functional ovule and course of pollen-tube ; c. chalazae ; e. embryo-sac ; g. caecum of embryo-sac ; p. pollen-tube. K : Section of a branchlet showing stomata at the bottom of which are the stomata ; i. inner bundles.

PLATE X

See p. 137



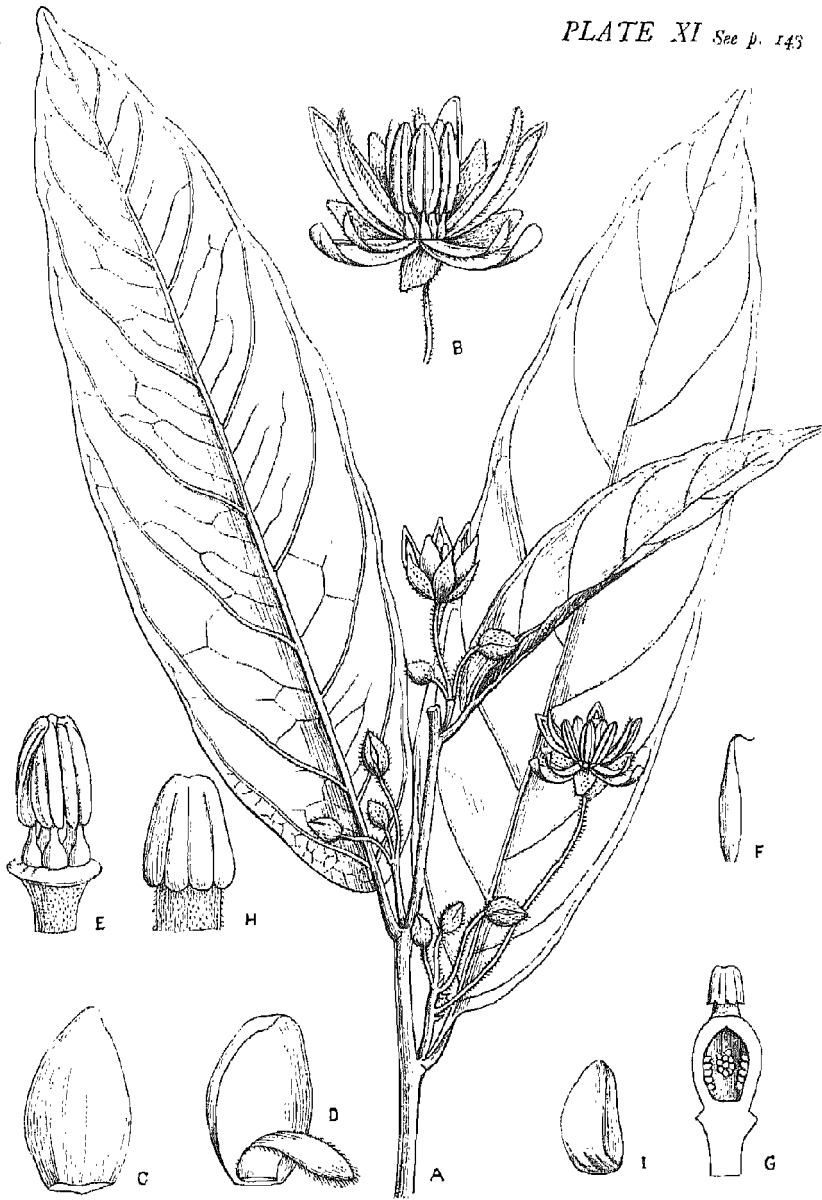
See p. 141



MORACEAE

1. *Morus alba* Linn. A : Twig with male flowers $\times 1/2$. B : Female flower ; ovary seated in a perianth of four tepals $\times 10$. C : Longitudinal section through ovary showing 1-locular ovary with a single pendulous ovule $\times 10$. D : Style with stigmatic lobes $\times 20$. E : Stamen $\times 10$. *Morus nigra* Linn. F : Leafy twig $\times 1/2$. G : Fruiting twig $\times 1$. H : Female flower $\times 10$. I : Style and stigmas $\times 15$. J : Seed $\times 5$. K : Transverse section through seed $\times 6$. L : Longitudinal section through seed showing position and shape of the embryo $\times 6$. (Both after Hegi)

CANNABINACEAE (See facing page)

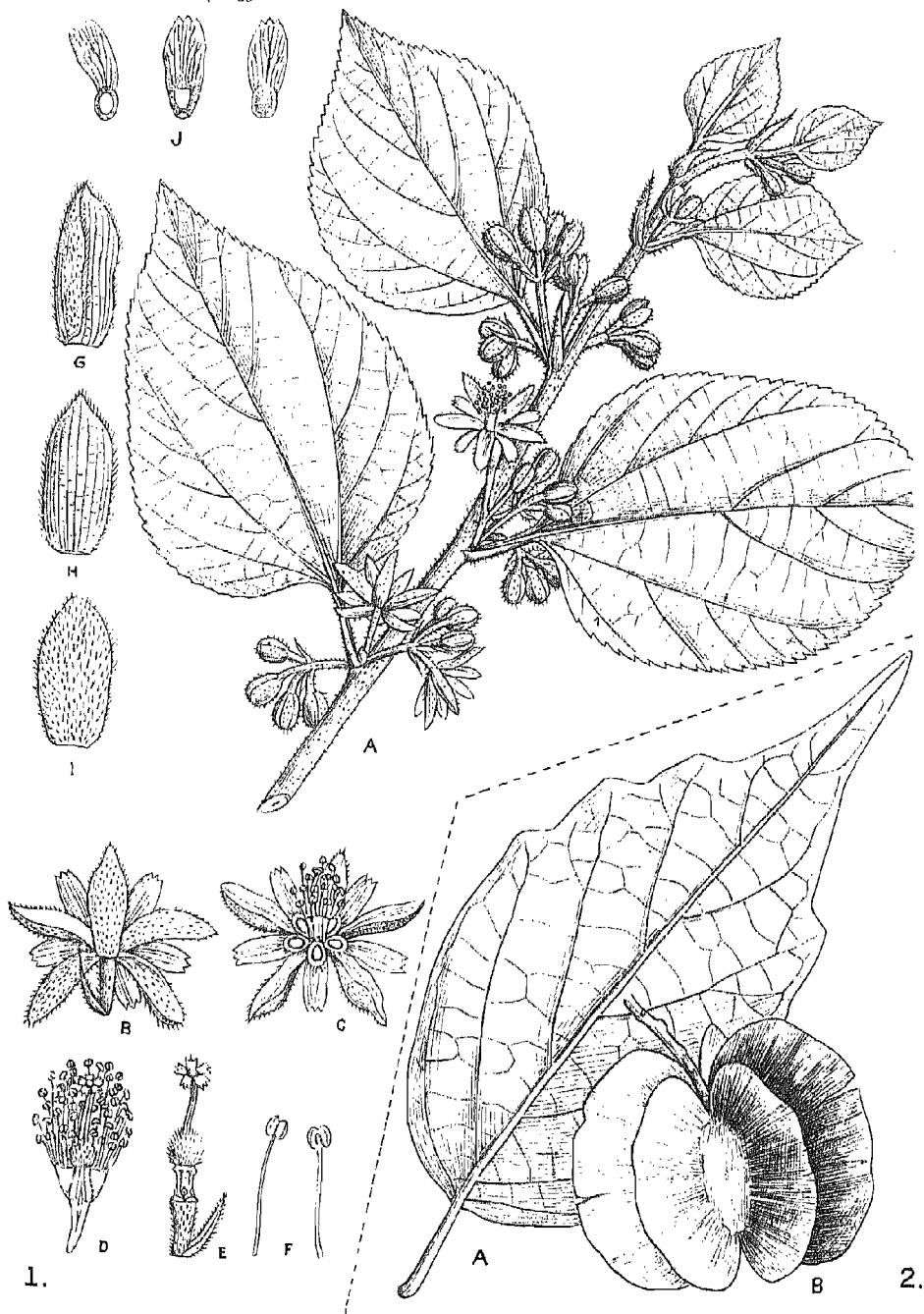


FLACOURTIACEAE

Hydnocarpus anthelmintica Pierre. A : Tip of a flowering branch $\times 1$. B : Flower $\times 2$. C : Sepal $\times 3$. D : Petal with scale $\times 3$. E : Group of stamens $\times 5$. F : Staminode $\times 5$. G : Ovary and style, showing the placentation $\times 3$. H : Style and stigma $\times 5$. I : Seed $\times 1$. This species, found in Indo-China and Thailand, is closely related to *H. daronensis* and *H. verrucosa*, both Burmese species. (After *Flor. Gén. de l'Indo-Chine*)

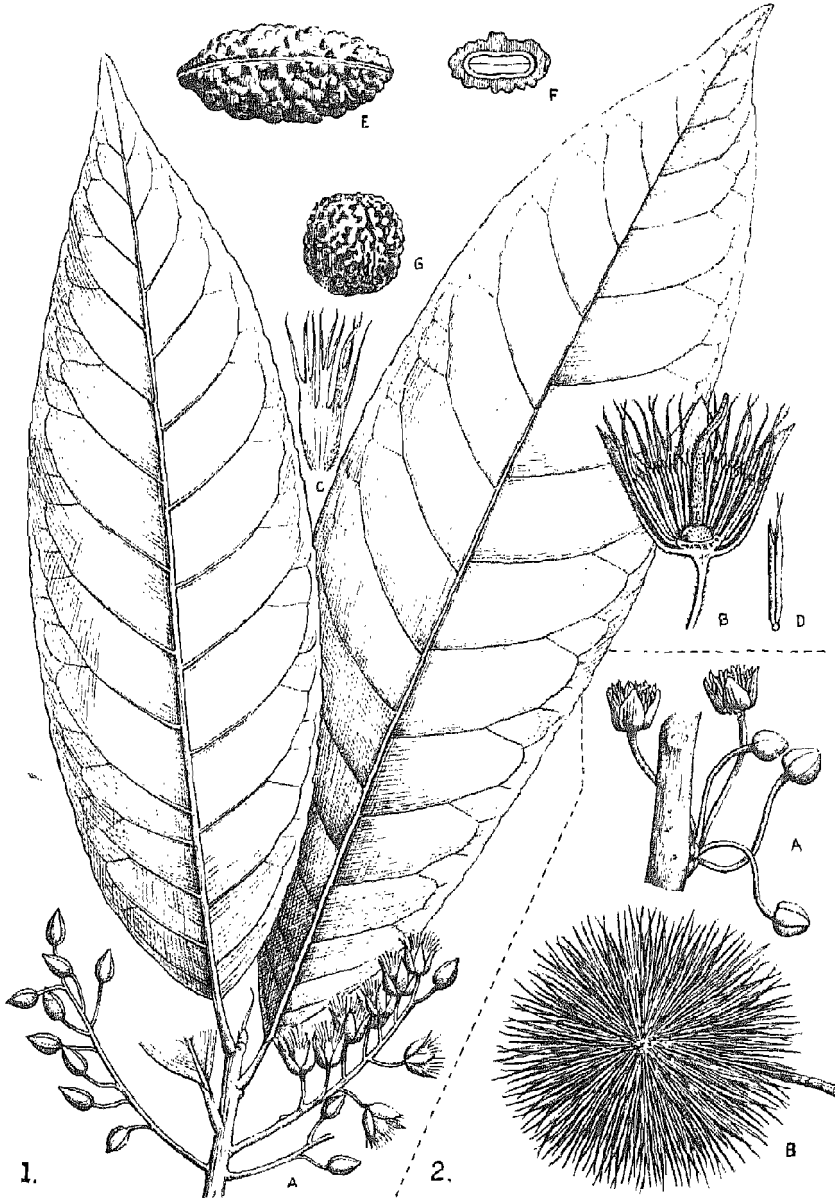
CANNABINACEAE

2. *Cannabis sativa* Linn. A : Female plant $\times 1/2$. B : Female flower enclosed in bract $\times 2$. C : Female flower, consisting of a 1-locular ovary containing one pendulous ovule ; stigmas very long $\times 2$. D : Mature ovary still in its bract $\times 2$. E : Cross section of 1-seeded nut $\times 2$. F : Seed $\times 3$. G & H : Embryo removed from seed $\times 4$. I : Plan of female inflorescence ; in the centre the leafy axis. J : Male flower pendulous ; perianth of five lobes with a stamen opposite each $\times 2$. (After Hegi and Eichler)



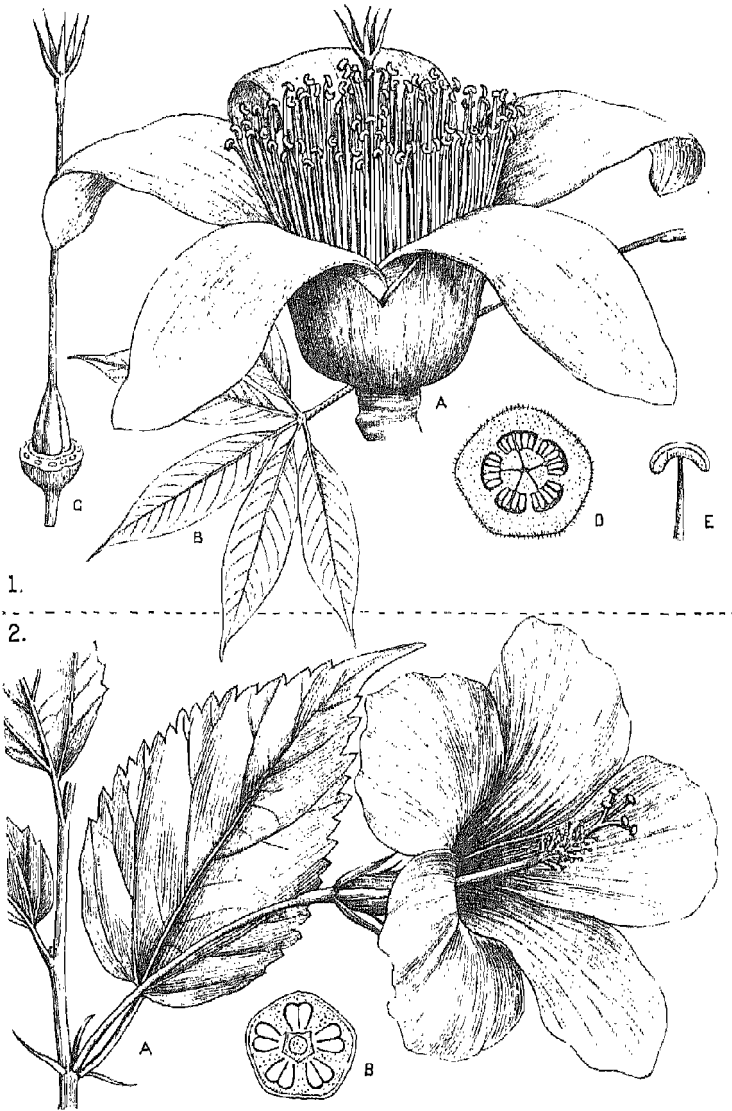
TILIACEAE

1. *Grewia hainesiana* Holc. A: Flowering branch $\times 1$. B: Outside view of flower $\times 2$. C: Flower opened; ovary and half androecium removed $\times 2$. D: Androecium and gynaeceum; stamens on a androphore $\times 2$. E: Gynaeceum $\times 4$. F: Stamens $\times 4$. G, H & I: Sepals $\times 4$. J: Petals showing gland at the base $\times 3$.
2. *Pentace burmanica* Kurz. A: Leaf $\times 1$. B: Fruit, somewhat resembling fruits of *Terminalia* $\times 1$.



ELAEOCARPACEAE

1. *Elaeocarpus ganitrus* Roxb. A : Tip of branch with leaves and portion of the inflorescence $\times 1$. B : Section of the flower showing superior ovary and stamens and behind the laciniate petals and sepals $\times 4$. C : Single petal with laciniate lobes $\times 8$. D : Anther showing method of dehiscence ; one loculus aristulate $\times 5$. E : *E. tuberculatus* Roxb. Stone, strongly compressed and deeply tuberculate and F : its cross section $\times 1$. G : *E. robustus* Roxb. Stone, globose and 3-grooved $\times 1$.
2. *Sloanea assamica* Rehd. et Wils. (*Echinocarpus assanicus* Benth.). A : Portion of the inflorescence $\times 1$. B : Fruit, a spiny 3-valved loculicidal capsule $\times 1$.

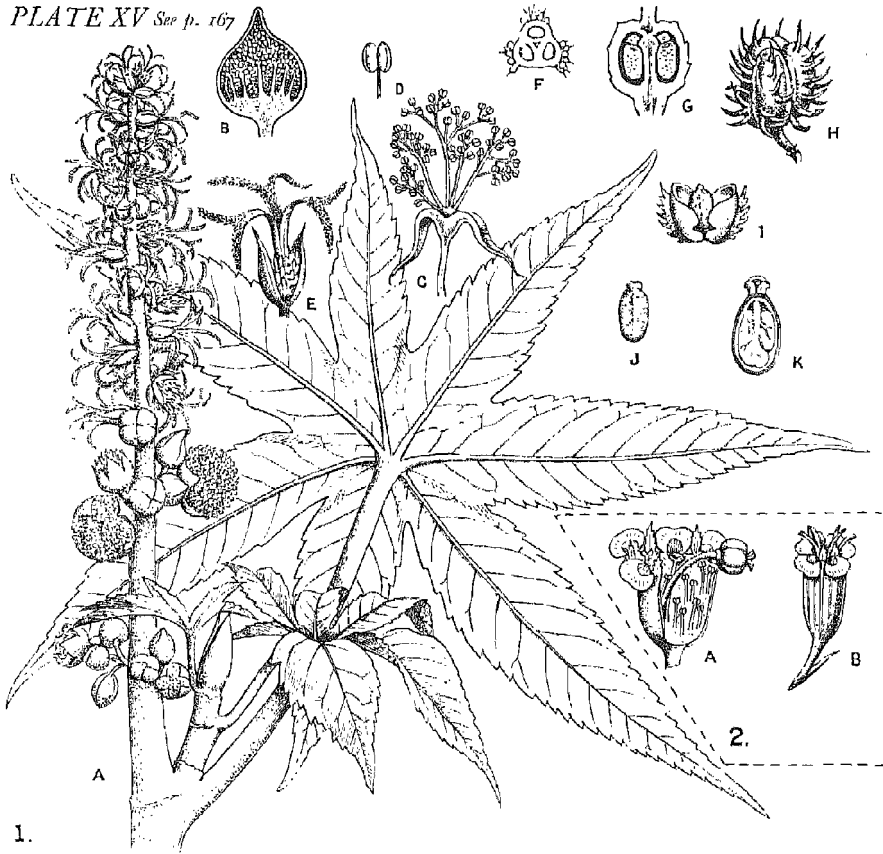


BOMBACACEAE

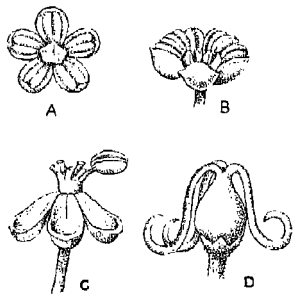
1. *Salmalia malabarica* Schott. et Endl. (*Bombax malabaricum* DC.). A : Flower $\times 1$. B : Digitately compound leaf $\times \frac{1}{3}$. C : Ovary, long style, 5-lobed stigma $\times \frac{3}{2}$. D : Cross section of the young ovary ; the central space is 5-locular by intrusion of parietal placentas $\times 6$. E : Anther 1-locular $\times 6$.

MALVACEAE

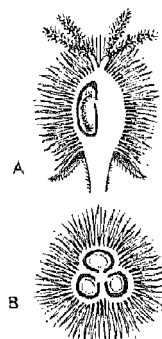
2. *Hibiscus rosa-sinensis* Linn. A : Flowering twig ; observe the epicalyx, the monadelphous stamens, and the 5-lobed style ending in five capitate stigmas $\times \frac{1}{2}$. B : Transverse section of the ovary showing five loculi. The ovules are in two vertical rows $\times 6$.



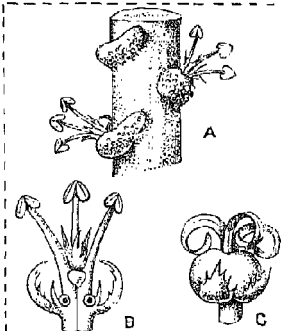
1.



3.



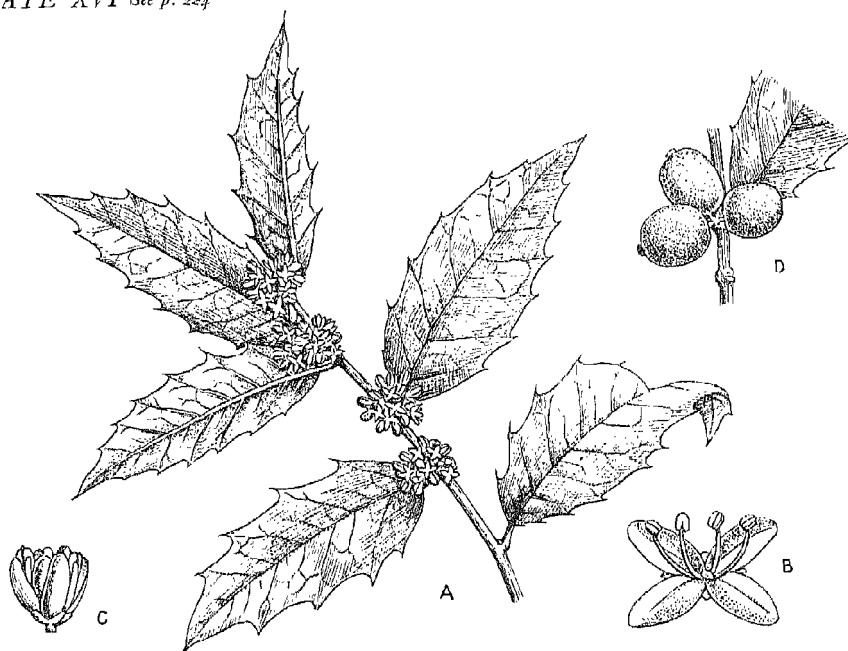
4.



5.

EUPHORBIACEAE

1. *Ricinus communis* Linn. A: Upper part of flowering branch $\times \frac{2}{3}$. B: Unopened male flower $\times 2$. C: Opened male flower $\times 2$. D: Anther $\times 10$. E: Female flower $\times 2$. F: Ovary in transverse section. G: Ovary in vertical section, showing ovules and obturator $\times 10$. H: Capsule $\times 1$. I: Coccus split open $\times 1$. J: Seed $\times 1$. K: Seed cut to show embryo $\times \frac{3}{2}$. (Rendle, *Flor. Jamaica*)
2. *Euphorbia hypericifolia* Linn. A: Cyathium cut open to show male flowers and female flower $\times 24$. B: Cyathium $\times 16$. (Rendle, *Flor. Jamaica*)
3. *Bischofia javanica* Bl. A, B and C: Male flower. A and B $\times 8$, C $\times 10$. D: Female flower without calyx $\times 7$.
4. *Chaetocarpus castanocarpus* (Roxb.) Thw. A: Vertical section of immature fruit showing ovule and obturator. B: Transverse section of same. (After Pax)
5. *Excoecaria agallocha* Linn. A: Portion of the male inflorescence showing individual flowers $\times 8$. B: Male flower $\times 11$. C: Female flower $\times 7$.



AQUIFOLIACEAE

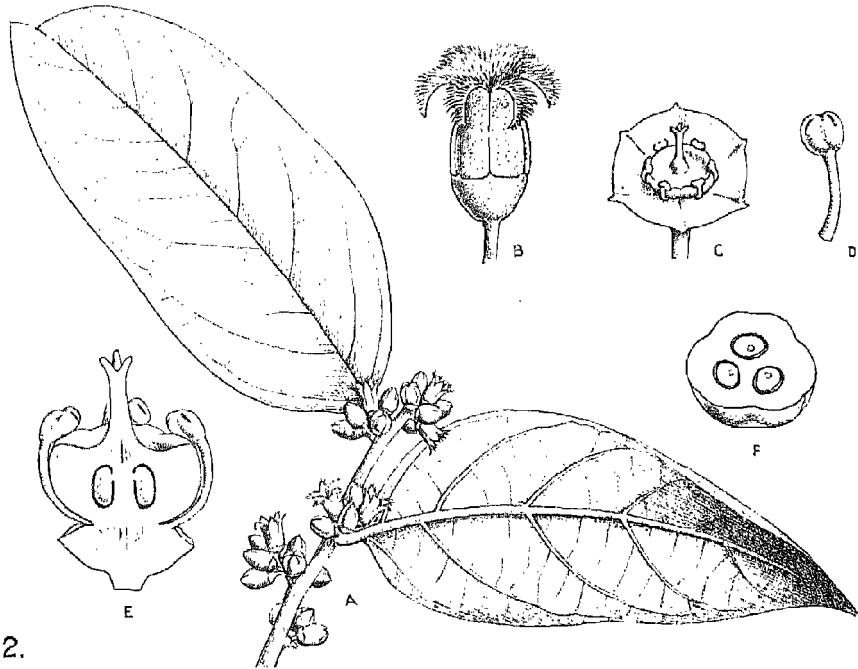
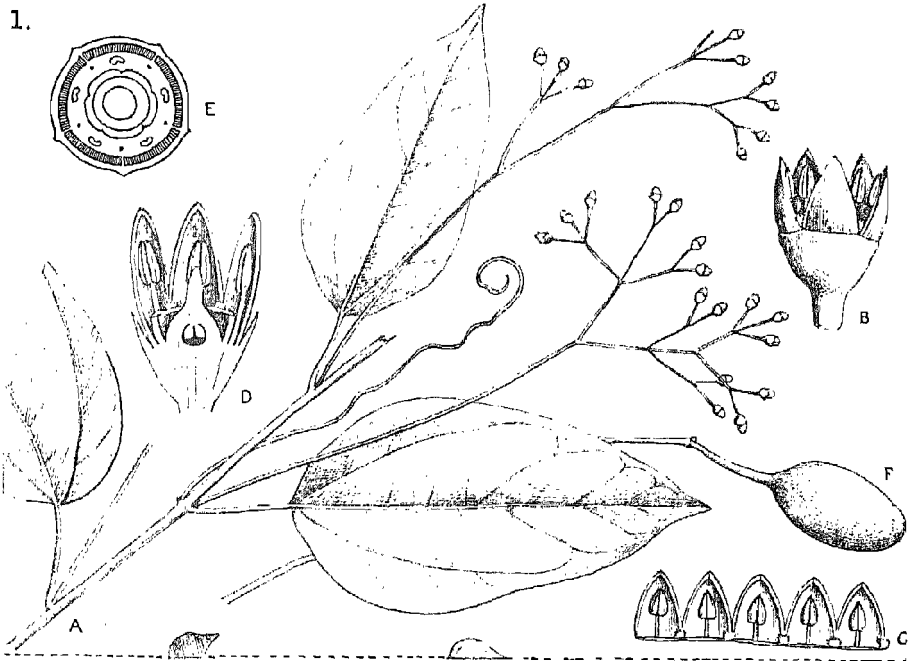
Ilex dipyrrena Wall. A : Flowering twig $\times 1$. B : Male flower ; four sepals, four petals and four stamens $\times 2$. C : Flower (hermaphrodite) just opening $\times 2$. D : Fruit ; the berries are bright red in colour $\times 1$. (After Collett)

OLACACEAE

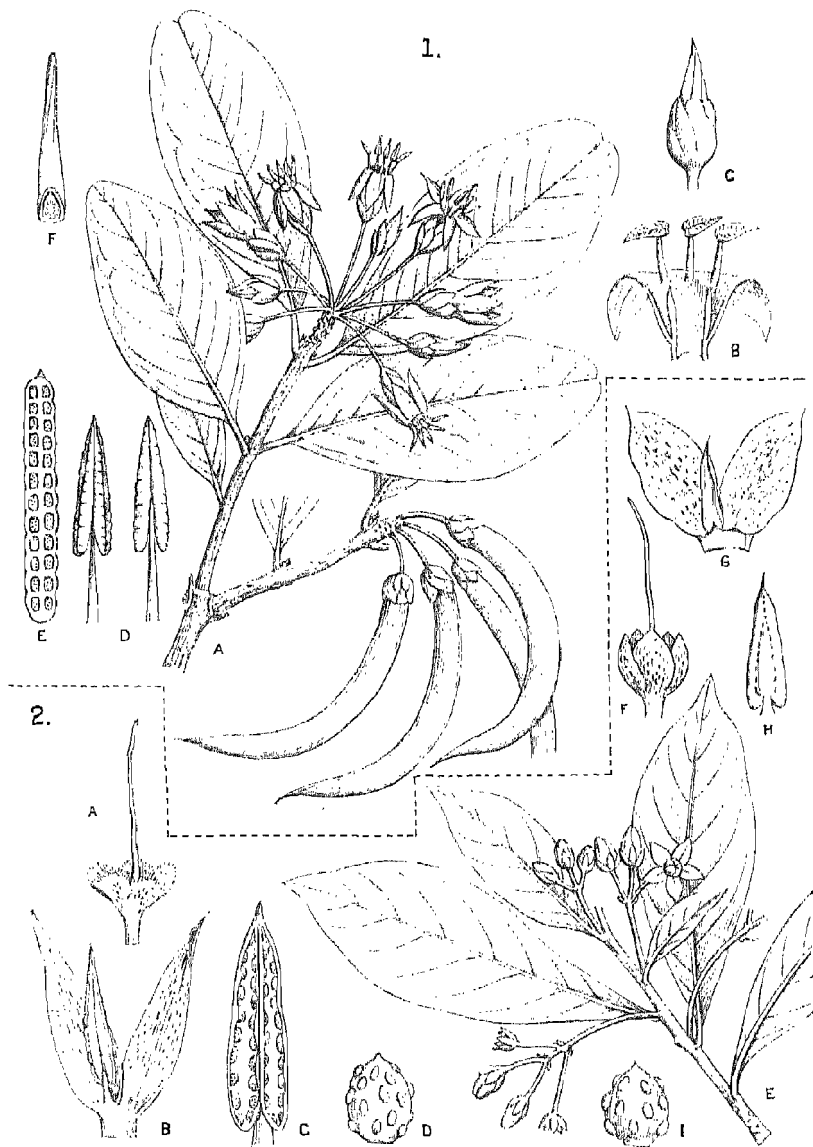
1. *Erythrophalum scandens* Bl. A : Flowering shoot $\times 1/2$. B : Flower $\times 4$. C : Corolla opened out showing the stamens opposite the petals and the staminodes alternate with them $\times 4$. D : Section of the flower, showing uni-locular ovary with pendulous ovules ; disk prominent $\times 4$. E : Diagram of the flower. F : Fruit $\times 1$.

2. *Anacalosa densiflora* Bedd. A : Flowering branch $\times 1/2$. B : Individual flower ; calyx 6-toothed ; petals six, valvate, hairy within $\times 4$. C : Flower with petals removed showing 6-toothed calyx, prominent disk ; six stamens alternate with the calyx-teeth and therefore opposite to the petals $\times 4$. D : Stamens showing dehiscence $\times 8$. E : Section of the ovary showing the ovary sunk in the disk $\times 8$. F : Loculi three ; ovule one in each loculus $\times 8$. (After Beddome)

1.



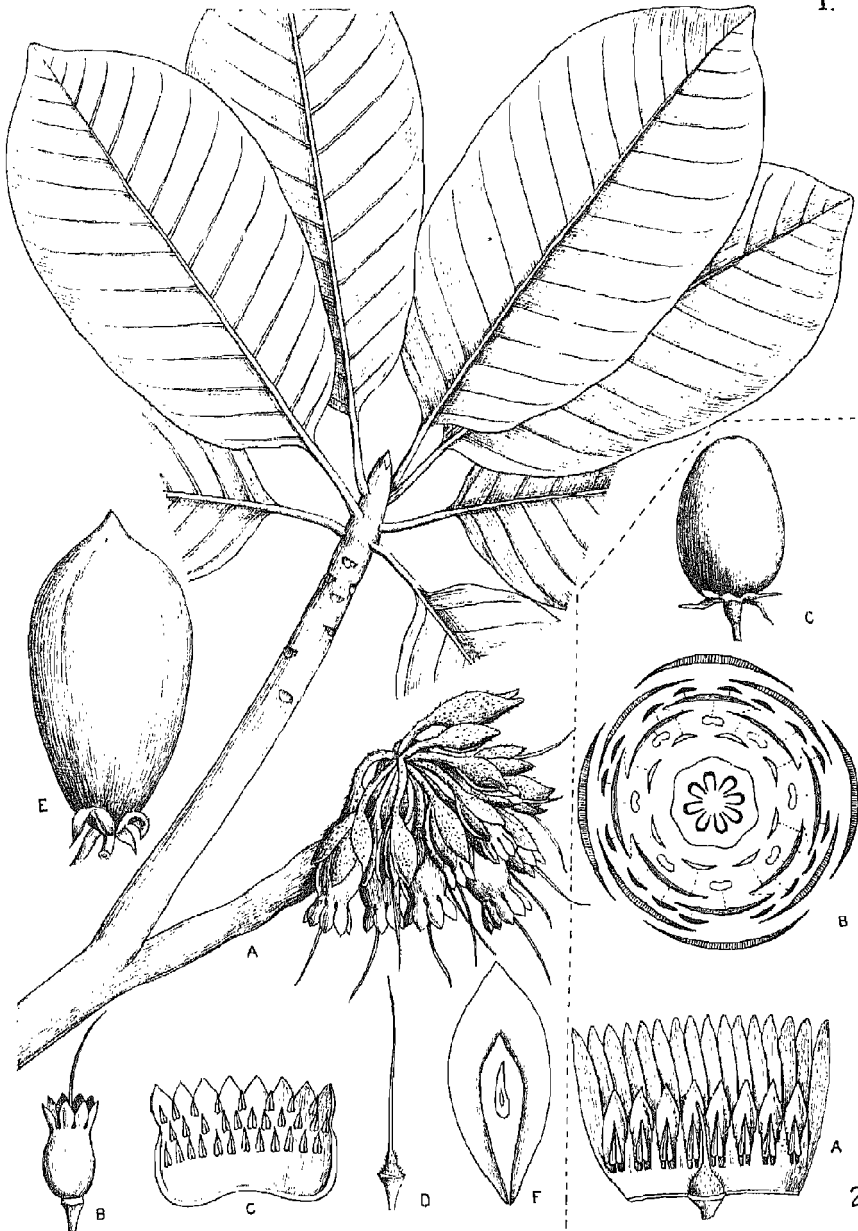
2.



MYRSINACEAE

1. *Aegiceras corniculatum* (Linn.) Blanco. A: Twig showing flowers and fruits $\times 1$. B: Section of the corolla showing the reflexed lobes and three of the five stamens $\times 2$. C: Bud showing the twisted sepals and petals $\times 2$. D & E: Stamens showing the transversely septe anther loculi $\times 4$. F: Ovary with portion cut away to show the free central placenta $\times 4$. (After Mez)
2. *Ardisia humilis* Vahl. A: Flower after the corolla has fallen away, showing the gland-dotted sepals $\times 2$. B: Portion of the corolla with gland-dotted petals and stamen opposite to the petal $\times 2$. C: Stamen with septe anthers $\times 4$. D: Placenta (free-central) showing position of ovules. *Ardisia solanacea* Roxb. E: Twig with inflorescence $\times 1/3$. F: Calyx $\times 2$. G: Portion of corolla and stamen $\times 2$. H: Stamen $\times 3$. I: Placenta, showing ovules. (After Mez)

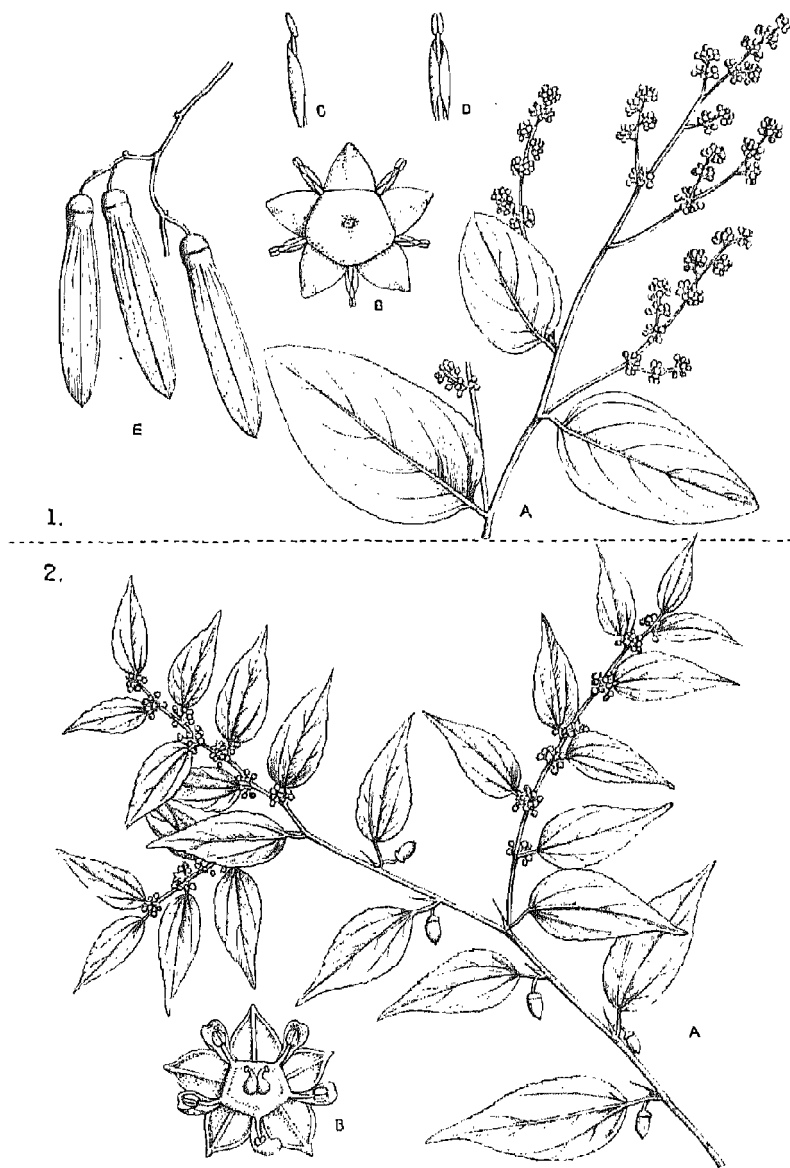
1.



SAPOTACEAE

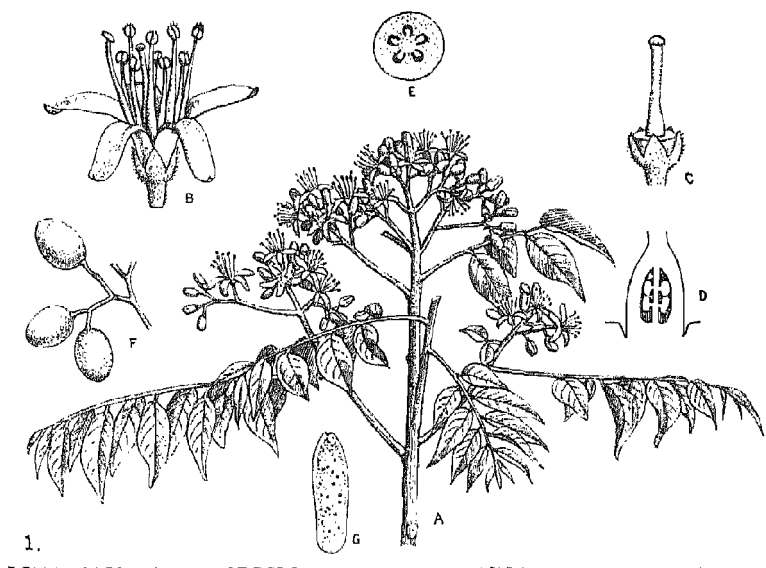
1. *Madhuca latifolia* (Roxb.) Mcbr. (*Bassia latifolia* Roxb.) (After Roxburgh). A: Leafy branch with leaves and fascicled inflorescence $\times 1/2$. B: Corolla (8-lobed) after removal of sepals $\times 1$. C: Corolla opened out showing the sessile anthers in three rows $\times 1$. D: Ovary with long style and stigma $\times 1$. E: Fruit $\times 1$. F: Longitudinal section of seed showing embryo $\times 1$.

2. *Mimusops elengi* Linn. A: Flower with corolla opened out flat, showing stamens alternating with staminodes and opposite to the petals. Each petal has a two-lobed dorsal appendage $\times 3$. B: Diagram of the flower. C: Fruit $\times 1$.

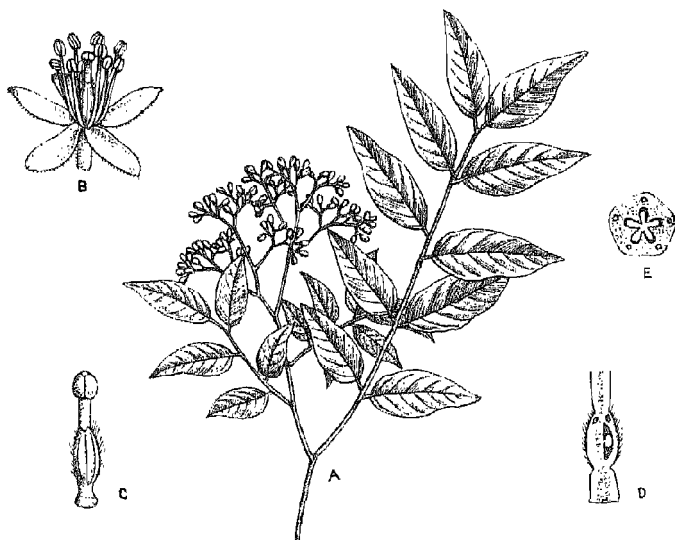


RHAMNACEAE

1. *Ventilago calyculata* Tul. A : Flowering twig $\times 1$. B : Flower showing broad disk, five sepals and five stamens, the filament of each embraced by a petal $\times 10$. C & D : Filament embraced by the petal $\times 20$. E : Fruit, a winged nutlet $\times 1$.
2. *Zizyphus oxyphylla* Edgew. A : Flowering and fruiting twig $\times \frac{1}{2}$. B : Flower, showing five sepals and five stamens each of the latter opposite a petal $\times 10$.



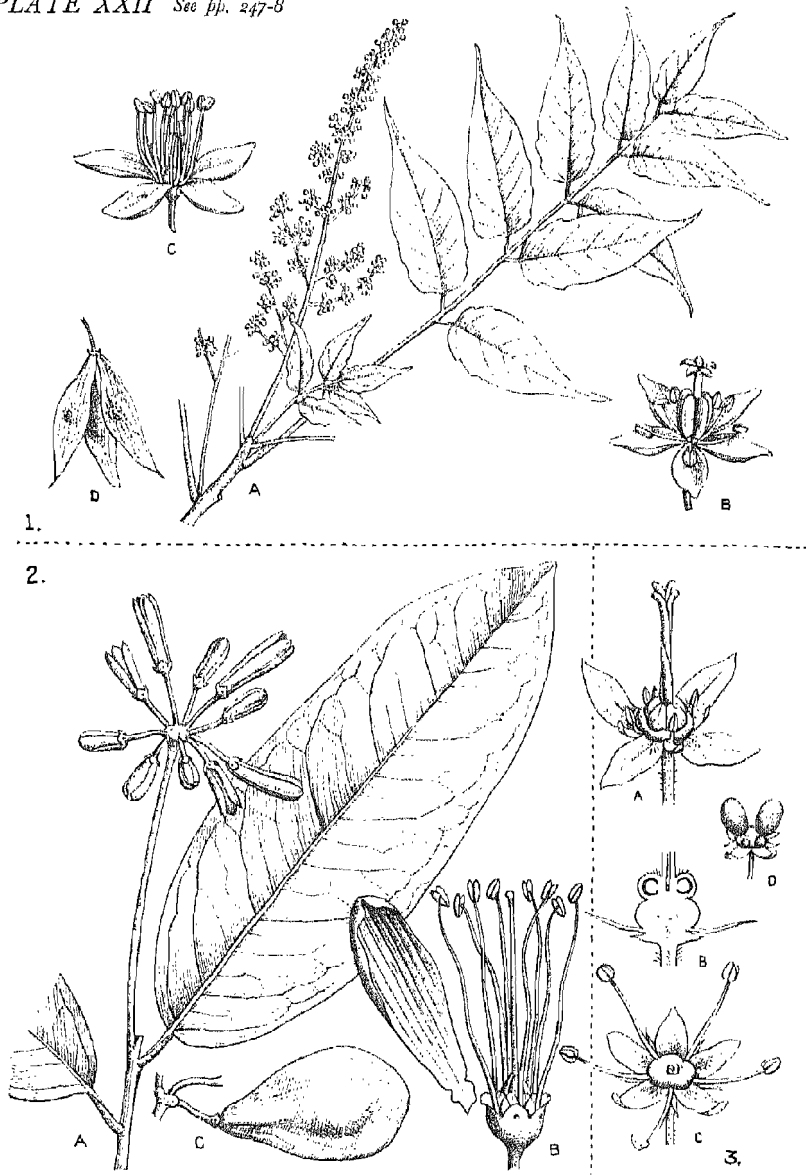
2.



RUTACEAE

1. *Murraya koenigii* Spreng. [*Chalcas koenigii* (Linn.) Kurz] (After Koorders). A : Flowering branch $\times \frac{1}{2}$. B : Flower showing the five petals and ten stamens, the latter with subulate filaments $\times 4$. C : Flower with stamens and petals removed, showing the ovary seated on a fleshy disk $\times 4$. D : Vertical section of the ovary showing two superposed ovules in each loculus $\times 8$. E : Cross section of the ovary $\times 10$. F : Fruit $\times 1$. G : Petal glandular $\times 4$.

2. *Micromelum pubescens* Bl. [*M. integerrimum* (Roxb.) W. et A.] (After Koorders). A : Flowering twig $\times \frac{1}{4}$. B : Flower ; stamens ten ; petals five $\times 2$. C : Ovary $\times 4$. D : Section of the ovary ; ovule one in each loculus $\times 8$. E : Cross section of the ovary showing five loculi $\times 16$.



SIMARUBACEAE

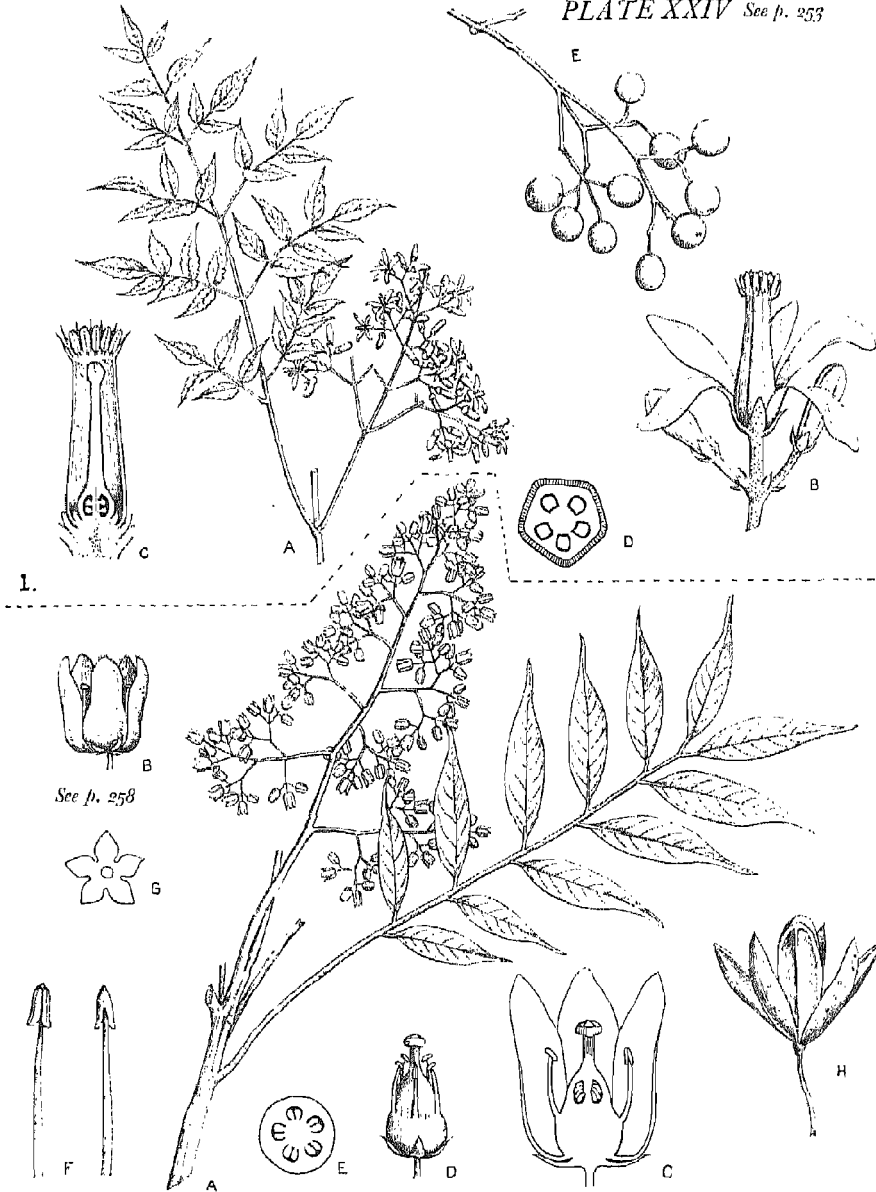
1. *Ailanthus glandulosa* Desf. A : Flowering branch $\times 1/8$. B : Hermaphrodite flower showing the 5-partite ovary $\times 3$. C : Male flower, stamens twice as many as the petals $\times 3$. D : Fruit of 1-seeded samaras $\times 1/3$.
2. *Samadera indica* Gaertn. A : Flowering branch, calyx very small $\times 1/2$. B : Flower showing one petal (of eight or ten) ; stamens eight, each with a scale at the base $\times 2$. C : The characteristic 1-seeded winged drupe $\times 1/2$.
3. *Picrasma javanica* Bl. A : Female flower with reduced stamens, ovary 5-partite ; styles twisted $\times 4$. B : Section of the ovary ; ovules solitary in each loculus $\times 6$. C : Male flower, showing disk with reduced ovary and five stamens alternate with the petals $\times 4$. D : Fruit of 2-4 fleshy drupes on the enlarged torus $\times 1/2$.



BURSERACEAE

1. *Protium serratum* Engl. (*Bursera serrata* Colebr.). A: Flowering twig $\times \frac{1}{2}$. B: Flower; petals five; sepals five $\times 10$. C: Flower with petals removed showing ovary seated in a disk and seven of the ten stamens $\times 20$. D: Cross section of the ovary; loculi five, with two collateral ovules in each loculus $\times 20$.

2. *Canarium bengalense* Roxb. A: Inflorescence $\times \frac{1}{4}$. B: Leaf $\times \frac{1}{3}$. C: Calyx 3-lobed $\times 6$. D: Stamens six $\times 10$. E & F: Petals three $\times 5$. G: Fruit $\times 1$. (Partly after King)



2.

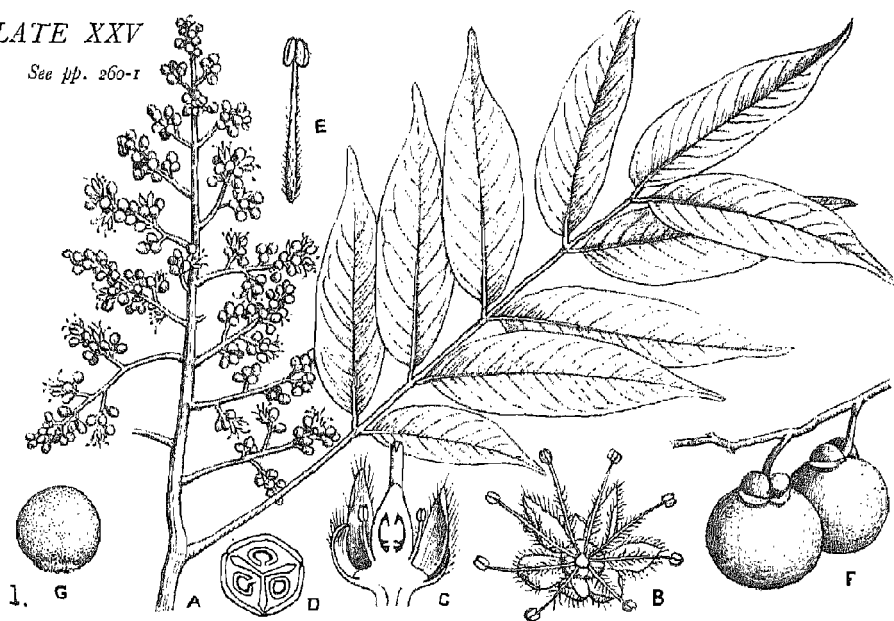
MELIACEAE

1. *Melia azadirach* Linn. Persian Lilac. A : Flowering twig showing the flowers in panicles and the bipinnate leaves $\times \frac{1}{3}$. B : Flowers lilac-coloured, pentamerous; staminal tube visible $\times 3$. C : Vertical section of the staminal tube and ovary, showing the cupular disk between tube and ovary; ovules two in each loculus, superposed $\times 4$. D : Transverse section of the ovary showing the five loculi $\times 9$. E : Fruiting twig; fruit a berry with five or fewer seeds $\times \frac{1}{3}$. (C & D after Harms; the remainder after Hegi)

2. *Cedrela toona* Roxb. A : Flowering twig with flowers and young leaves; mature leaves are more oblique than those figured $\times \frac{1}{3}$. B : Flower $\times 2$. C : Vertical section of the flower showing the stamens and ovary seated upon a thick disk; ovules 8-12, biseriate, pendulous (only four seen in each loculus) $\times 5$. D : Flower with petals removed. Note the free stamens and capitate stigma $\times 4$. E : Cross section of the ovary showing the five loculi with biseriate ovules $\times 5$. F : Stamen, front and back view $\times 8$. G : Calyx $\times 5$. H : Fruit a capsule with septicidal dehiscence $\times 1$.

PLATE XXV

See pp. 260-1



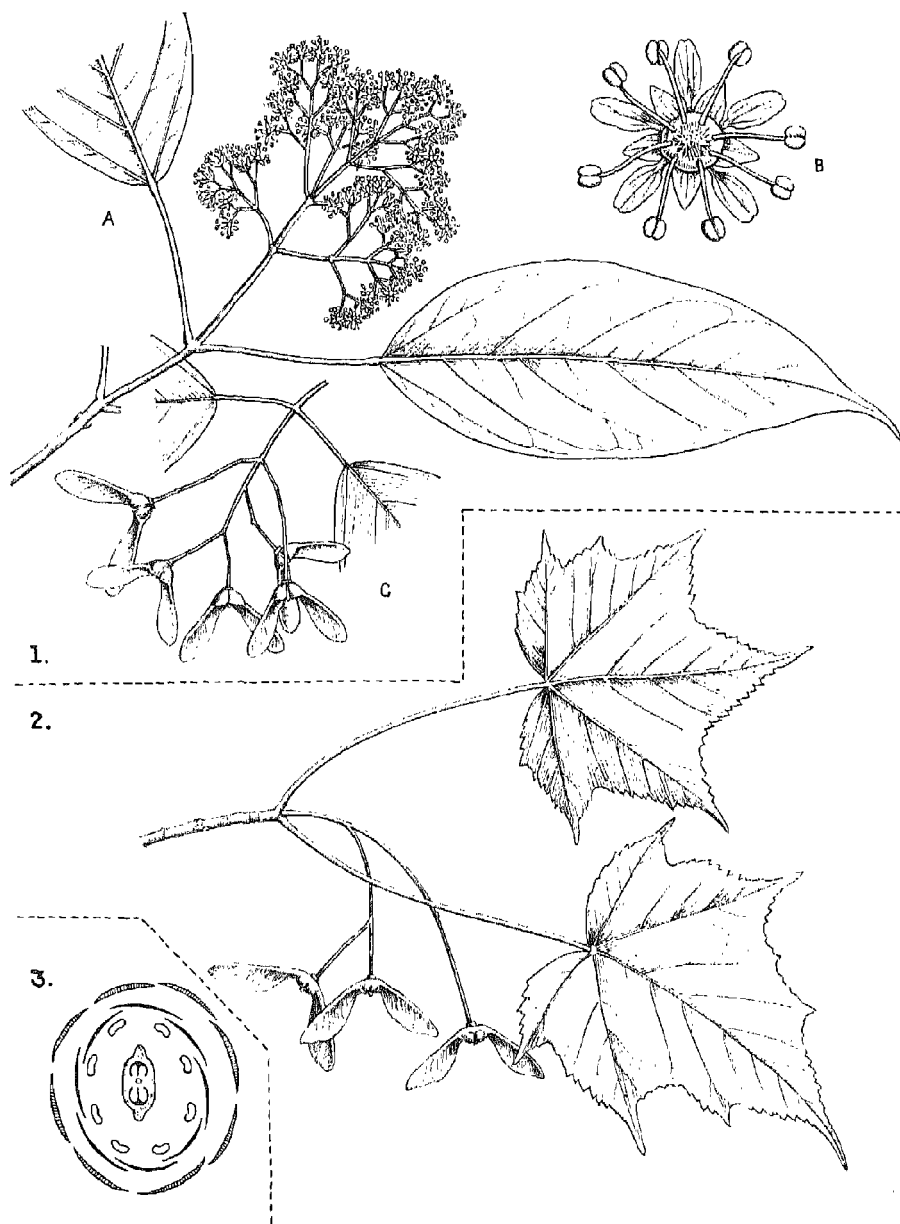
2.



SAPINDACEAE

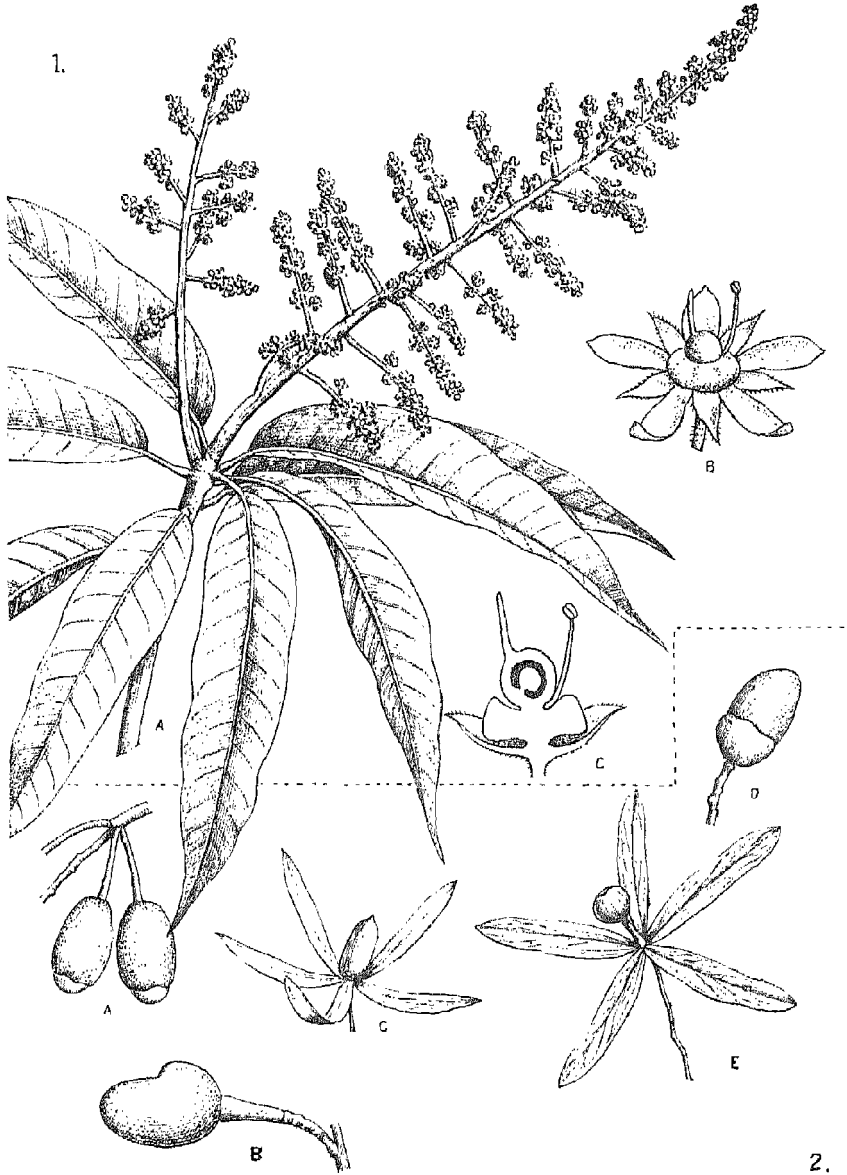
1. *Sapindus detergens* Roxb. A: Tip of flowering branch showing compound leaf and panicle $\times \frac{1}{2}$. B: Male flower; sepals five, petals five, disk exterior, stamens eight $\times 4$. C: Vertical section of female flower; stamens rudimentary, inside the disk; gynaeceum superior; ovules axile, one in each loculus $\times 8$. D: Cross section of the ovary showing three loculi $\times 16$. E: Stamen $\times 5$. F: Fruits showing persistent calyx $\times \frac{7}{8}$. G: Fruit without calyx $\times \frac{3}{4}$.

2. *Aesculus indica* Colebr. A: Flowering twig showing digitate petioluled leaflets $\times \frac{1}{2}$. B: Flower showing campanulate calyx, four petals and seven stamens $\times 2$. C: Flower with calyx opened and petals removed to show the fleshy disk outside the stamens $\times 2$. D: Vertical section of the ovary; placentation axile $\times 3$. E: Transverse section of the ovary; loculi three $\times 6$. F: Diagrammatic section of the flower, showing the irregularity in the attachment of the four petals. G: Anthers and portion of filaments $\times 6$.



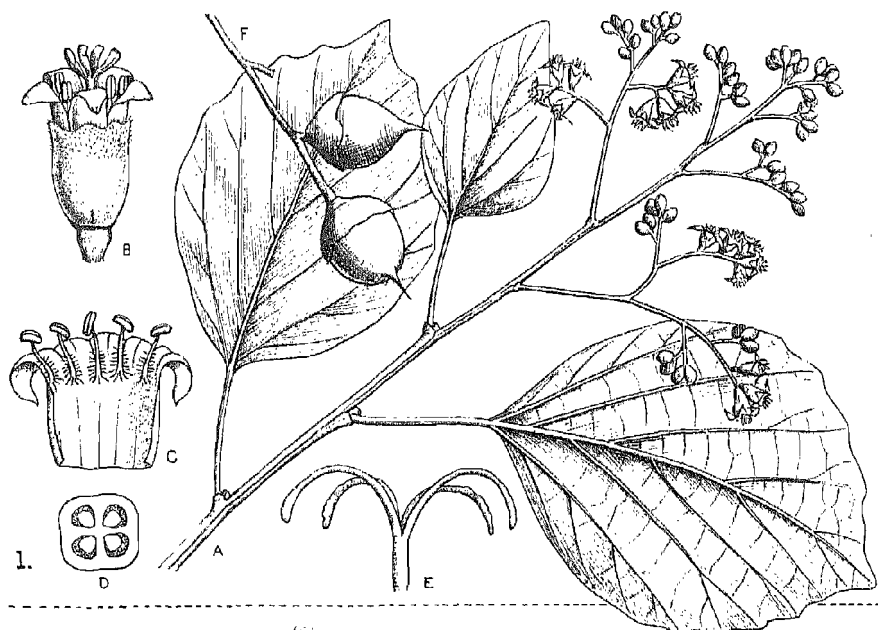
ACERACEAE

1. *Acer oblongum* Wall. A : Twig with inflorescence ; leaves simple $\times 1$. B : Male flower ; petals and sepals few ; stamens eight, within the disk $\times 4$. C : Fruiting twig $\times 1/2$.
2. *Acer caesium* Wall., showing a branch in fruit ; leaves maple-like $\times 1/2$.
3. Diagram of *Acer pseudoplatanus* Linn., showing eight sepals, petals and stamens ; ovary 2-locular, compressed contrary to the septum.



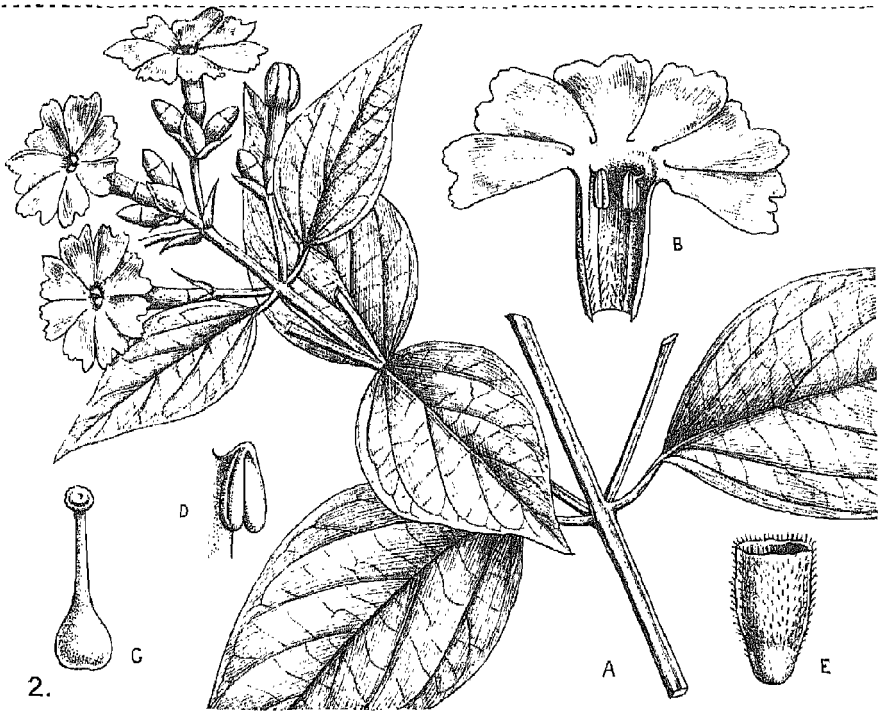
ANACARDIACEAE

1. *Mangifera indica* Linn. A : Flowering twig $\times \frac{1}{2}$. B : Flower. Sepals five ; petals five ; ovary seated in a disk ; stamen one, the remaining four absent or obsolete $\times 2$. C : Ovary 1-locular, 1-ovuled $\times 3$.
2. Anacardiaceous fruits. A : *Holigarna grahami* Hook. f. $\times 1$. B : *Anacardium occidentale* Linn. $\times \frac{1}{2}$. C : *Swintonia floribunda* Griff. $\times \frac{1}{1}$. D : *Semecarpus anacardium* Linn. f. $\times \frac{1}{2}$. E : *Melanorrhoea usitata* Wall. $\times \frac{1}{4}$.



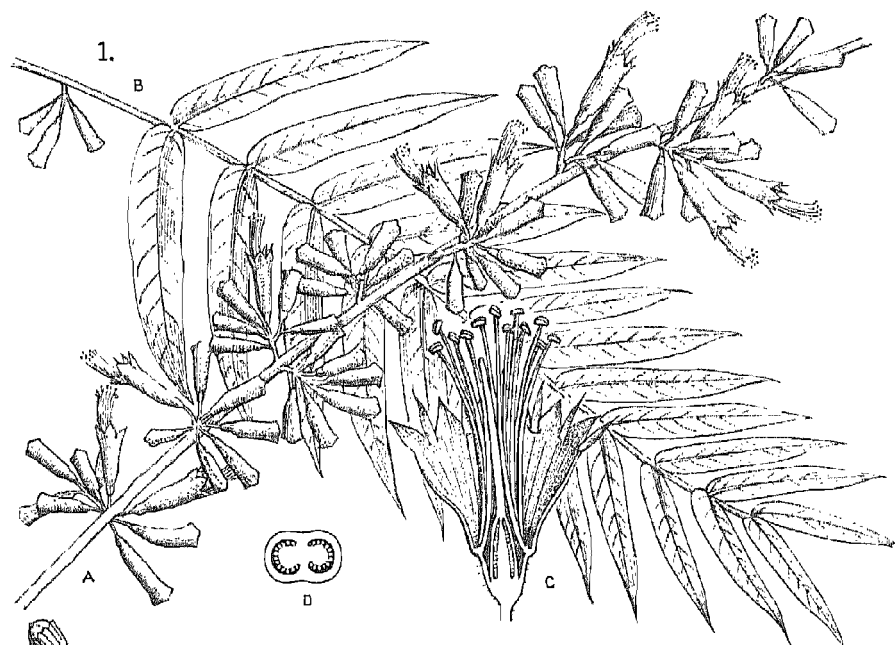
EHRETIACEAE

1. *Cordia dichotoma* Forst. f. A : Flowering branch $\times 1$. B : Individual flower showing the 4-partite style just beginning to emerge $\times 6$. C : Corolla opened out showing attachment of stamens $\times 6$. D : Cross section of the ovary, 4-locular ; ovule one in each loculus $\times 10$. E : Style. F : Fruit a capsule $\times 1$.
2. *Ehretia laevis* Roxb. A : Flowering branch $\times 1$. B : Flower $\times 4$. C : Ovary showing 2-partite style $\times 4$. D : Ovary 2-locular in vertical section ; ovules two, pendulous in each loculus $\times 5$. E : Corolla opened out showing attachment of the stamens $\times 4$. F : Fruit $\times 1$. (After Wight)



OLEACEAE

1. *Jasminum pubescens* Willd. A : Flowering twig $\times 1$. B : Flower $\times 3$. C : Corolla cut open to show the two stamens $\times 6$. D : Fruit $\times 1$.
2. *Nyctanthus arbor-tristis* Linn. A : Flowering twig $\times 1$. B : Corolla cut open to show the two stamens $\times 2$. C : Ovary $\times 2$. D : Sessile anther $\times 4$. E : Calyx $\times 2$. (After Bot. Mag.)





SOLANACEAE

Solanum nigrum Linn. A : Flowering and fruiting branch $\times 1/2$. B : Flower showing the reflexed petals and yellow cone of stamens $\times 2$. C : Diagram of the flower. D : Stamen showing dehiscence by pores $\times 8$. E : Fruits $\times 1$. F : Section of a fruit showing seeds $\times 1$.

LYTHRACEAE

1. *Woodfordia fruticosa* (Linn.) Kurz. A : Flowering branch $\times 1$. B : Leafy twig $\times 1$. C : Vertical section of flower $\times 2$. D : Cross section of ovary showing the two loculi and many ovules on axile placentas $\times 5$.

2. *Lagerstroemia speciosa* Pers. A : Flowering branch ; note the ribbed calyces $\times 1/2$. B : Capsules showing loculicidal dehiscence $\times 1$. C : Section of a flower showing the numerous almost hypogynous stamens $\times 1$. D : Cross section of ovary ; five loculi with many ovules on axile placentas $\times 4$.